SCIENTIFIC AMERICAN

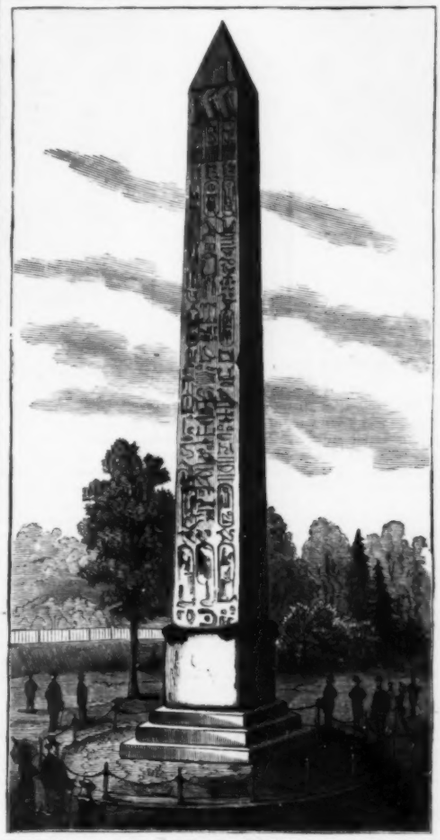
SUPPLEMENT, No. 267

Scientific American Supplement, Vol. XI., No. 267. Scientific American, established 1845. | NEW YORK, FEBRUARY 12, 1881. | Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

THE EGYPTIAN OBELISK IN AMERICA.

THE Egyptian obelisk, presented a few years ago to the people of the United States by the Viceroy of Egypt, has at last been transported from the distant banks of the Nile, and erected, with its base and pedestal, in the Central Park of New York. The work of removal was planned and executed by Lieut. Commander H. H. Gorringe, U. S. N., and it is much to his credit as an engineer to say that the venerable and gigantic stone, the ancient of days, has been taken up and transported, over land and sea, and erected in the New World, without the slightest accident or injury. This has required the most unremitting care at every step of the removal, for a little inattention or relaxation of care might have resulted in the cracking or permanent marring of the precious relic. One of the obelisks formerly carried to Italy was broken in two during the operation of removal. The obelisk that was taken from Egypt to London in 1877 was for a time lost at sea. It was removed in a special float

THE OBELISK AS IT STOOD IN ALEXANDRIA PRIOR TO REMOVAL TO NEW YORK.



THE OBELISK AS IT NOW STANDS IN CENTRAL PARK, NEW YORK.

and towed behind a steamer. During a gale the tow rope parted, the monolith disappeared, and was given up for lost. Subsequently, however, it was picked up by a passing vessel, towed to Spain, and finally landed in England.

The last touch in the work of removal and setting up of the Central Park obelisk was given on the 22d of January, 1881, when the great stone was swung from horizontal to vertical position and lowered to its resting place on the pedestal. If it remains there for as many years as it stood in Egypt, New York will by that time probably have fallen to ruins, like the proud city from which this same monument has come. When that time arrives perhaps Egypt will have recovered her ancient glory and will seek to carry the wondrous block home again.

Probably our readers will be interested if we give them, in connection with some particulars of the history of this hoary stone, a brief account of some of the other more extraordinary architectural remains, which in prehistoric times made Egypt the wonder of the world.

We will first speak of the Central Park obelisk, and refer to the pyramids and other objects in separate articles.

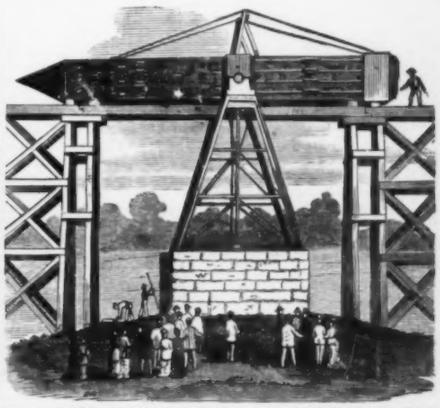
The people of the United States are primarily indebted for this obelisk—a most precious possession—to Mr. William Henry Hurlburt, the accomplished editor of the New York *World*. It was he who first suggested and urged its removal to New York; and his suggestion was acted upon and backed up by the liberality of one of our wealthy citizens, who offered to pay all the expenses, provided his agency in the matter could be kept *sub rosa*. The secret has been so well kept that the name of the generous individual has not yet been positively announced, but it is suspected that the credit belongs to Mr. William H. Vanderbilt, who is known to do many handsome things in the same way. We find in the New York *World* and the N. Y. *Daily Graphic* a variety of interesting particulars concerning the obelisk, from which we derive the following particulars:

It is considered by Egyptologists that the obelisk and the pyramid were forms symbolical of the rising and the setting sun.

There are about forty Egyptian obelisks, great and small. Obelisks were erected on the east of the River Nile, pyramids on its western bank. The rising sun, which extended to noonday, was the visible manifestation, in their pantheistic nature-worship of the generative and preservative power, which the Egyptians worshiped by the name of Ra, or Life. The setting sun, ultimately including night, was the token of death, and the dark underworld into which the human soul would at last descend as the sun disappears beneath the horizon. This was called Tum, and the pyramids dedicated to it were used as sepulchers for illustrious persons. The Egyptian temples, on the contrary, in which the gods of Life, Light, and Truth were worshiped, had their gates adorned with pairs of obelisks, which also served as monuments to record the name and fame of the monarchs by whom they were set up. The most ancient obelisk known is supposed to be about 5,000 years old.

The two obelisks which were removed by Octavius or Augustus Cæsar from Heliopolis to Alexandria, in honor of Julius Cæsar, are those popularly called "Cleopatra's Needles." One of these is the one now in London, and the other in New York. Doubt has been cast upon the propriety of connecting the name of Cleopatra with these shafts, but inasmuch as she died only a few years before their removal, it is altogether within range of probability that she designed their removal and their erection at the Cæsarium at Alexandria.

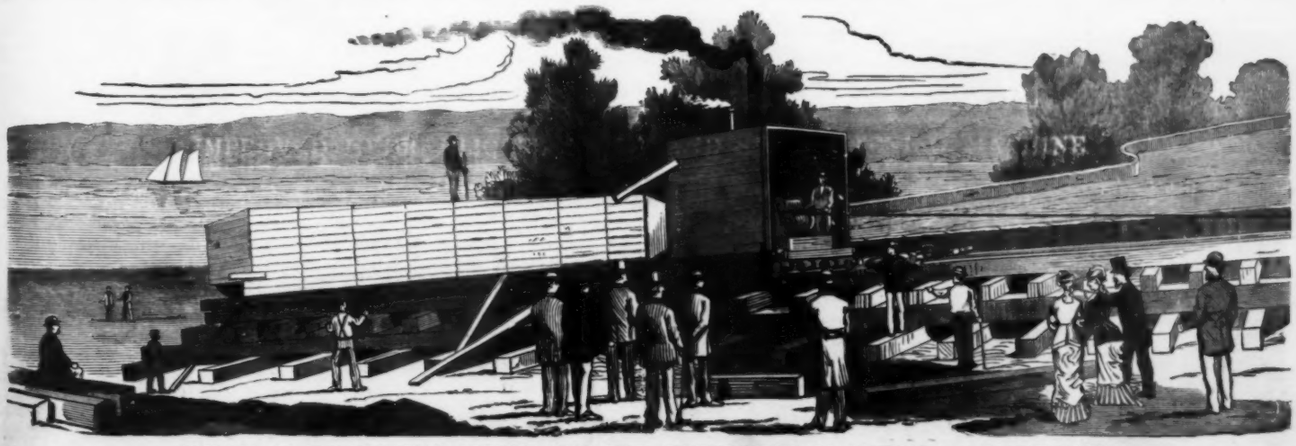
These two obelisks were erected at On, or Heliopolis, about 1,600 years before the birth of Christ, together with the pair of obelisks, one of which is now at Constantinople and the other at Rome. The Pharaoh, or King, by whom



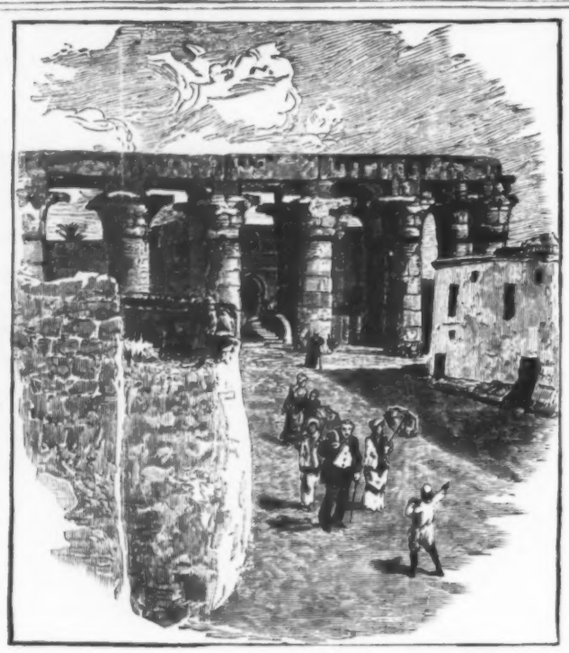
THE OBELISK AS MOUNTED ON TRUNNIONS FOR SWINGING

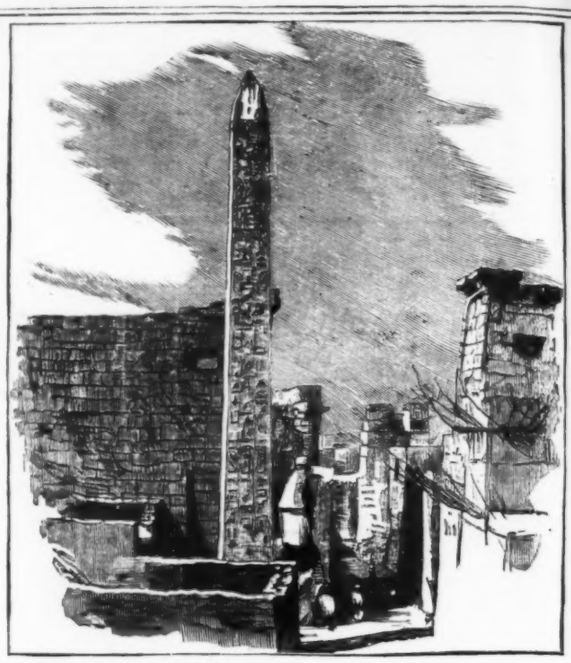
they were originally set up was Thothmes III.; but one of his successors, Rameses II., or Sesostris, as the Greeks called him, who reigned two centuries later, added the side lines of hieroglyphic inscriptions, in his own honor and glory, while the middle perpendicular line sets forth the renown of the proper constructor and donor of the monolith. The London obelisk is 68 feet 5½ inches high, somewhat less than that of its mate in Central Park.

The erection of obelisks in Egypt ceased 3,000 years ago, their construction having begun 1,000 years earlier. Two thousand years ago, when Egypt was conquered by the Romans, they carried away a great many of the obelisks as the most remarkable trophies they could take from the country. Eleven were transported to Rome. One, called the Obelisk of Theodosius, was transported to Constantinople. Several were taken to cities in Asia, others were overturned and have been buried up in the sands or otherwise lost to history. The number now left in Egypt is so small, and their archæological value so well understood by the government of Egypt, that there is no reasonable expectation that any more will ever be allowed to be taken away.



ROLLING OF THE EGYPTIAN OBELISK FROM THE HUDSON RIVER TO CENTRAL PARK, NEW YORK.





THE GREAT TEMPLE AND OBELISK NOW STANDING AT LUXOR.

The Egyptian obelisks are all of red granite, from quarries near the banks of the Nile at Syene, just below the first cataract. The modern name of the place is Assouan. One obelisk is still remaining in the quarry three-fourths quarried out, one side alone of it still being part of the original rock. This one is about 20 feet square and 70 feet long. For some reason unknown at the present day the purveyor of obelisks probably failed. When it was discovered some years ago they found under the obelisk some of the tools used by the workmen three thousand years ago. The contractor for obelisks to the Egyptian kings evidently transported them from the quarry to the river on a gentle inclined plane or wooden tramway, which he built under his obelisk as it lay in the quarry attached by one side to the ledge of rock. When he had got three sides of his obelisk finished and his tramway laid on the under side and his rollers all fixed, then he started a row of wedges the whole length of the obelisk, close together, and by driving them all at once split it off from the quarry, when it dropped on the roadbed and on rollers arranged for its transportation. Then as it moved slowly down a short distance to the bank of the river, the rollers as they were left behind by the moving obelisk were brought forward and put in front of it, and in this way the obelisk was moved from the quarry to the immense boat awaiting in a dock on the bank of the Nile to receive it. On being rolled on board of the boat it was then transported down the river from 500 to 1,000 miles to the location of the temple or palace in front of which it was to be erected.

When Alexander the Great founded Alexandria at the mouth of the Nile he did not stop to quarry and transport new obelisks to decorate his city, but he and his followers took as many as they wanted from the temples and palaces where they had been erected from one thousand to fifteen hundred years before by the Egyptian kings, put them on enormous boats constructed for the purpose, and floated them down to Alexandria and re-erected them there. Afterwards the Romans, following his example, brought eleven of them down the Nile to Alexandria, and there re-embarked them in enormous ships especially constructed for the purpose, and bore them across the Mediterranean to Italy, and used them to decorate the city of Rome.

The favorite location in Rome by the Romans for an Egyptian obelisk was on the middle of the spina in a circus as a part of the decoration of the spina. These circuses were enormous structures of brick and stone, some 1,200 feet long and 400 feet wide. The spina was a stone structure which ran through the center of it, coming within about 200 feet of each end, and in the races the chariots went down one side of the spina, turned at the end, and came up the other side. In the center of this spina, if it was a first-class imperial circus, was erected the Egyptian obelisk.

The obelisk of Theodosius, at Constantinople, is erected in one of the public squares.

The largest obelisk ever erected is the one now standing in front of the Church of St. John Lateran, at Rome. This, when first brought to Rome, was 110 feet high and weighed 450 tons. The Lateran obelisk is memorable in history as being one of the pair—the largest in the world and the most richly-engraved with hieroglyphics—erected by King Pheron, of Egypt, some 2,000 years B.C., in front of the Temple of the Sun, at Heliopolis, to commemorate the restoration of his sight, after ten years' blindness, by the aid of a wash furnished him under the direction of an oracle by the chaste wife of a workman employed in the king's gardens. It is narrated of this king that he celebrated the recovery of his sight by shutting up in a palace and burning to death a large number of noble ladies, including his queen, who had failed to cure him. He afterward married the successful wife of the gardener. This obelisk was brought from the temple, in front of which it had been erected, down the Nile to Alexandria, by Constantine the Great. After his death it lay neglected for some years, until his son, the next Emperor, transported it to Rome, and it was erected on the spina of the Circus of Maximus. It stood there for several centuries, until Rome was sacked and destroyed by the Goths and Vandals, when it was overturned, it is supposed, by building fires at its base and so shelling the base off, and, in falling, broke into three pieces and lay buried up in the ruins nearly 1,000 years, when it was dug out and transported two miles, to the front of the Church of St. John Lateran. A few feet were cut off from its base to get a square for it to stand upon, and the three pieces were so carefully joined together that the fractures are now scarcely visible. The shaft of this obelisk is now 105 feet 7 inches in height.

The next obelisk in size is on the Piazza at St. Peter's, at Rome. This was formerly one of the decorations of the spina of the circus in the rear of the tomb of the Emperor Hadrian, which is now the castle of St. Angelo. This is 83 feet and 2 inches in height and weighs 916,000 pounds. The next in size is one in the center of the Piazza Dei Popolo, in front of the gate Del Popolo. It is 78 feet high. The fourth one in size at Rome is the one now erected on Monte Citorio. It is 71 feet 6 inches in height. The fifth one in size is that now erected in the Piazza Navona as a part of the decoration of a public fountain. The rustic base of the obelisk is some 20 feet in height, and the obelisk itself is 51 feet. The sixth in size at Rome is the one now erected on Monte Cavalo, in front of the Quirinal Palace, in which formerly Popes were elected, but now the palace is the official residence of the King of Italy. The seventh in size at Rome is erected in front of the Church of Santa Maria Sopra Minerva. This is 39 feet high. The eighth is on Monte Pincio, and is 30 feet in height. The ninth is erected in the square in front of the Pantheon. This and the other two are smaller.

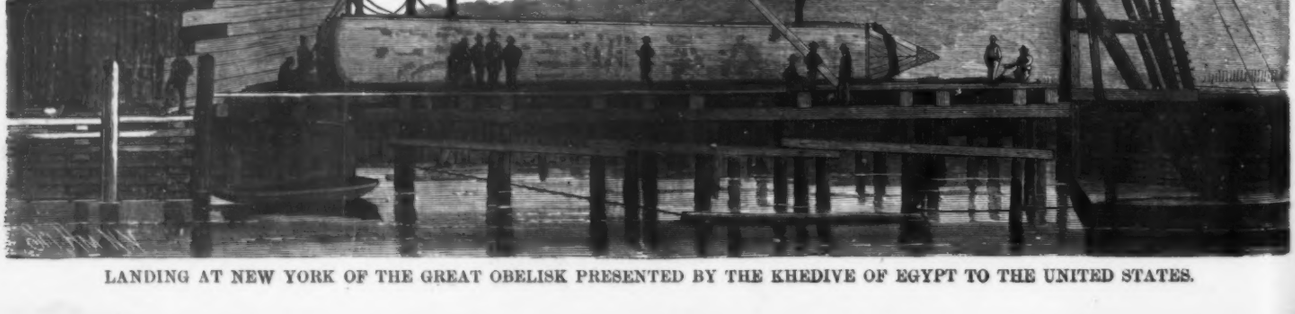
The granite of which Egyptian obelisks are made, when polished, looks very much like the Scotch red granite or the red granite of Connecticut. It is not a pure granite nor a pure syenite, being composed of quartz, feldspar, and hornblende, with a small percentage of crystals of mica. Were it not for the mica it would be what is now called the syenite. Perhaps the more exact name for it would be syenitic granite. Whether this material will stand our climate is yet to be determined.

The Central Park obelisk has stood 3,500 years in Egypt, where the climate is dry and the temperature always warm, rains and frosts being scarcely known. One side of this obelisk for a portion of its height has been worn away, apparently by the sands of the desert being blown against it, or by the effect of the dew and the sun on the grains of the rock, to the extent of from one to two inches in depth. The other three sides are quite perfect and show the original polish put upon it thirty five centuries ago.

All granite will absorb water more or less. The coarse-grained granite will take in so much water that when it freezes it throws apart the grains and the outer layer of grains falls off. Some of the precipices in the Rocky Mountains that are composed of red granite, like that of the obelisk, only coarser grained, have disintegrated so much by the effect of the wetting and freezing and thawing incidental to our climate that often several hundred feet of this *débris* are to be found lying at the foot of the precipices. The effect will probably be the same, although much less in degree, of the climate of New York upon this obelisk, unless some means can be devised to render the surface impervious to water. The obelisk at Paris has been erected only forty years, and the effect of the climate of France, although not nearly so severe as ours, is already manifest upon the obelisk of Luxor.

The monolith was formally ceded to Lieutenant Gorringe by the Governor of Alexandria on the 22d of October, 1870, and the work of removing it from its pedestal—of which the existence was first made known by Commander Gorringe's excavations—began at once. Commander Gorringe, before leaving the United States, devised and had manufactured all the apparatus for taking the obelisk off its base, placing it horizontally, and by an inclined trestle work lowering it to the ground. The apparatus consists chiefly of a pair of iron trunnions, 15 inches in diameter, firmly clamped to about the center of gravity of the obelisk, and a pair of steel derricks to support these trunnions. By steel rods attached to the clamps of the trunnions and extending to the base of the obelisk, where they were fastened to immense pieces of metal extending under the base and provided with double screw nuts, the obelisk was easily raised a few inches and turned on the trunnions to a horizontal, and then run down to the level of the ground on the trestle and into an immense float, or sort of floating dry dock, constructed for the purpose by Commander Gorringe. It was then taken seven miles around to the government dock at Alexandria and transferred to the hold of the steamship Dessoug, of 1,600 tons. The ship arrived at New York with its novel

3.



LANDING AT NEW YORK OF THE GREAT OBELISK PRESENTED BY THE KHEDIVE OF EGYPT TO THE UNITED STATES.

freight on the 20th of July, 1880, from which date its adventures are part of the local history of this city. The stone was rolled into and out of the steamer by removing a large number of the iron plates near the bow of the vessel. The huge stone was slowly and carefully trundled from the Hudson River on rollers through the streets to the Central Park, a distance of about two miles. It is an experience worth having to look upon a product of the human hands that rocked the cradle of civilization—to see a veritable structure that, before the Temple of the Sun, had reflected the sunlight for 1,500 years before Cleopatra was a sprightly girl and Mark Antony a lad without dreams of love.

DIMENSIONS OF THE CENTRAL PARK OBELISK.

There are no two sides of the obelisk or of the pedestal equal in width, and the sections through it are trapeziums. All the squares are calculated through their axes:

	Ft.	In.
Height of obelisk to pyramidion	61	7
Height of pyramidion	7	7
Height together	69	2
	Ft.	In.
Square at base	7	8¾
Square at top	5	3
Height of pedestal	6	11
Height of pedestal with obelisk	76	1
Square of pedestal at base	8	3
Square of pedestal at top	9	1
Height of bottom step at foundation	1	5½
Height of middle step of foundation	1	7
Height of top step of foundation	1	9½
Height of foundation, pedestal and obelisk	80	11
Width of bottom step	1	6
Width of middle step	1	2½
Square of foundation at base	17	8
Square of foundation at top	12	3½
Height from drive to top of obelisk	12	1
Height from drive to top of obelisk	93	0
Elevation of site above mean high water	101	6
Height of top of obelisk above mean high water	194	6
	Tons.	
Weight of the obelisk	219¼	
Weight of the pedestal	49	
Weight of the foundation	87¾	
Total net weight	356	

The obelisk has been moved since it was taken down 5,382 nautical miles by water and 11,520 feet by land.

THE INSCRIPTIONS ON THE OBELISK.

The inscriptions of Thothmes and of Rameses on our obelisk have been carefully translated by the accomplished Egyptologist, Brugsch Bey. They cover three sides of the column, and all of them relate to the glorification of the several Egyptian monarchs whose names are given. We select two of the inscriptions out of the twelve that are cut on the stone. The others are in much the same style as these examples, which read as follows:

No. 1.—Central Column of Thothmes III.

HORUS, who bears high the diadem of Upper Egypt, beloved by *Ra*, the King of the two lands (*Ra men cheper*), HORUS crowned with victory and rejoicing, who strikes the princes of the foreign countries. 100,000 are his whenever he raises his war-hatchet to give to *Ra* power over all the countries. All the strength is united in his hands to increase the joyfulness of the Son of the Sun, who is endowed with power, life, and constancy (Thothmes).

No. 2.—Central Column of Thothmes III.

The kingly HORUS, powerful Bull, crowned in Thebes, the lord of the diadems, whose royalty is expanded like the sun in heaven (*Beloved of Tum, Lord of Heliopolis, son of the lions, that created him Thothmes*) They created him in the great abode, from the perfection of their limbs, so that he will make an extended royalty for centuries. The King of Upper and Lower Egypt (*Ra men cheper*). Beloved of *Tum*, the Great God, and the gods of his circle, giving all life, stability, and happiness like the sun forever.

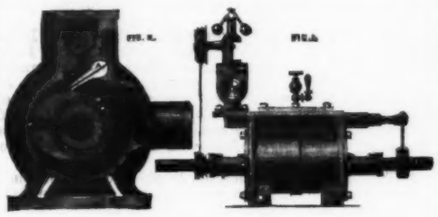
THE TEMPLE AND OBELISK OF LUXOR.

We give from the London *Graphic* a view of the celebrated Egyptian Temple of Luxor. The ruins of Luxor form, as we all know, the culminating point of all the wonders of the Nile; here stood ancient Egyptian Thebes; and if we are astonished at all the temples which, on both sides of the river, still laugh at Time's incapacity to destroy them utterly, though aided by the barbarous iconoclast, so also may we well be surprised at the absolute disappearance of a city whereof the ancient fame was spread almost from pole to pole. Abydus and Memphis are stated by Mariette to be the two most ancient cities of Egypt, as being contemporaneous with the foundation of the Egyptian monarchy; while Thebes makes her first appearance with the Kings of the Eleventh Dynasty, 3000 B.C. She attained her full glory during the Eighteenth Dynasty, 1700 to 1460 B.C., "when suddenly rose in its full extent and glory that city soon to be unrivaled in Egypt." These are the words of Mariette, who also adds, that after the period of Rameses III., of the Twentieth Dynasty, 1288 to 1110 B.C., when Medinet-Abou was built, and the celebrated tomb excavated, now known by the name of Bruce's, or the Harpist's Tomb, the period of Thebes' greatest magnificence and splendor ended. The temple of Luxor was built by Amunoph, or Amenhotep, III. Its ruins are greatly choked by buildings, but what there is remaining of the interior is sacred from the crowds that worry you everywhere with curiosities, noise, and begging for backsheesh. One remarkable feature in this temple is its now one solitary obelisk; its fellow being that which, taken away from its mother temple by the French, to-day adorns the Place de la Concorde at Paris.

A GOOD common black ink is prepared as follows: Dissolve 15 parts extract of logwood in 900 parts of water, allow to deposit, heat to boiling, and add four parts crystallized sodium carbonate. Dissolve in 100 parts of water 1 part of yellow potassium chromate, and add this drop by drop, with constant stirring, to the logwood solution. After standing for a few hours the ink will have assumed a full bluish-black color.

HODSON'S ROTARY ENGINE.

OUR engraving represents at Fig. 1 a side elevation, and at Fig. 2 a transverse section of this engine taken through the cylinder. In construction the cylinder is divided lengthways by a diaphragm, two piston cams, D, being keyed loosely on the shaft, S, one on each side of the diaphragm, and rotating in the direction of the arrow. These pistons are placed on the shaft in opposite positions to each other, by which arrangement the engine is perfectly balanced, and when the steam is exerting full power upon the one, the other is open to the exhaust, nearly equal pressure is maintained throughout the revolution of the shaft, and great regularity and steadiness insured. A is an abutment valve fitting into a recess in the cylinder; the tail of this valve rests on the surface of the cam as shown, and rises and falls as the piston rotates; the pressure of steam on top of the valve insures its always working tight, and also acts as a cushion to prevent it striking the top of the cylinder. There is a steam port, *p*, on each side of the diaphragm, by which steam is admitted to the two pistons by an oscillating valve, V. This valve is worked from an eccentric on the shaft, and admits steam to each piston alternately. The eccentric is set on the shaft, so that the steam is admitted by the valve, V, at the moment the point, *f*, in the cam arrives at the point, *g*, in the cylinder, and cut off when *f* arrives at *h*. The steam inclosed in the space, B, is then allowed to expand until *f* arrives at *j*, when the steam commences to escape into the exhaust cavity, C, and thence through the branch, F. Thus it will be seen that the steam is cut off at about



HODSON'S ROTARY ENGINE.

half-stroke—that is to say, the capacity of that part of the cylinder filled with steam, at the moment of cutting off, is doubled before the steam is allowed to exhaust. The rotating shaft bearings in the cylinder cover are kept steam-tight by the pistons working closely against the cover, the pistons being packed at the diaphragm ends by rings, E, made of phosphor bronze, kept up to the diaphragms by springs, *s*, and by tongues, *f*, kept up by springs, *s p*. One of the important features of this engine is an absence of other than metallic packing—glands and stuffing boxes being entirely dispensed with. The rotating shaft bearings in the cylinder covers are kept steam-tight by the pistons working closely against them. The metallic packing at the diaphragm ends, as also on the top, appear to have been well considered, and an allowance for wear taken into consideration; which, judging from practical experience extending over a considerable time, appears to have been very small. We are informed that the durability of the engine has been thoroughly tested by numerous trials, extending over four years—the result being very satisfactory. They have been in constant use driving electric light apparatus at Messrs. Siemens Brothers' works, and have given excellent results. They have also been in regular use at the Thames Ironworks at Blackwall, with equal success. Mr. Norwood Earle, 80 Cannon street, London, is Mr. Hodson's agent for these engines.—*Iron.*

IMPROVED ROTARY VALVE GEAR.

IN describing the stationary engines at the Dusseldorf Exhibition, we mentioned a small engine with rotary valves and automatic cut-off, exhibited by the Emmericher Maschinenfabrik of Emmerich. We illustrate, by Figs. 1 to 4 annexed, the essential features of this engine, namely, the construction of the valve and the method of working it. From Fig. 1, which is a side elevation of the engine to a small scale, it will be seen that only one valve is employed for the steam distribution, and this valve is of the rotating type and placed above the cylinder and parallel to it. It receives its motion (making one revolution to every four made by the engine) from a worm thread cut on the periphery of the crank disk, which works directly a screw wheel upon the valve spindle, the latter, therefore, extending along the whole length of the engine. By means of the connection which is outlined in Fig. 1, the valve can receive from the governor a small amount of endlong motion in the valve chest.

The actual construction of the valve and chest is shown in Figs. 2 and 3, and Fig. 4 is a development of the valve and face, showing the form of the ports in both. From these it will be seen that the valve is inclosed in a cylindrical box bolted directly to the cylinder. In this box and the cylinder there are four openings, two rectangular, A and B, the one for steam admission and the other for exhaust, and two trapezoidal, C and D, one communicating with each end of the cylinder. The openings, A and B, are side by side in the center of the cylinder face, C and D being beyond them at the ends. The shape and relative position of these openings is clearly shown in Fig. 4 in dotted lines. In the valve face itself there are four sets of openings, lettered E, F, G, and H respectively. The openings, E and F, are in the middle of its length and are rectangular, and considerably longer than the ports, A and B, to allow for the longitudinal motion of the valve. Each opening, F, communicates, as shown in Fig. 3, with a trapezoidal port, H, toward one end of valve, and each opening, E, with a similar opening, G, toward the other end. If one of the openings, E comes over A (as it is about to do in Fig. 4), the steam passes from A through E and G to C, and so through the passage to the left-hand end of the cylinder, while the space to the right of the piston communicates through D, H, and F with the exhaust port, B. The openings are so proportioned that both the point of steam admission and that of release are controlled by the edges of the ports, which are parallel to the axis, and remain therefore unaltered by any longitudinal motion of the valve. The cut-off, on the other hand, takes place against the beveled edges of the ports, and takes place, therefore, earlier or later, according to the position of the valve longitudinally, just as in the Rider gear. The work which the governor has to do, in shifting a valve which is in continual rotation, must be comparatively very small, and the control over the cut-off obtained in this way seems both simple and effective.

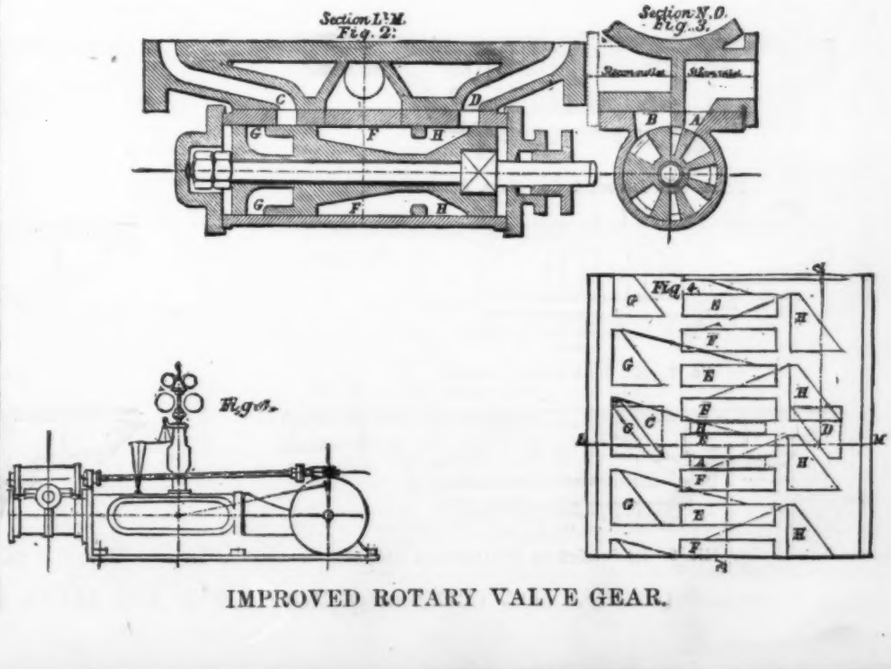
It should be noticed, as affecting very materially the good working of the valve from a practical point of view, that owing to the quadrupling of the ports, it is only necessary for the valve to be steam-tight over a comparatively small portion of its circumference; leakage on the back will, therefore, only help to keep it against the face, an advantage not always possessed by rotary valves. The arrangement is not probably suited for large engines, but for small ones it forms one of the very simplest, perhaps the very simplest, automatic cut-off gear which has been devised, and ought to give very good results.—*Engineering.*

IMPROVED LUBRICATOR.

THE engraving on next page is a form of lubricator for steam cylinders by De Limon, Fluhme & Co., of Dusseldorf. The principle of action of this lubricator is not entirely novel, but the manner in which the principle has been applied is very neat and convenient.

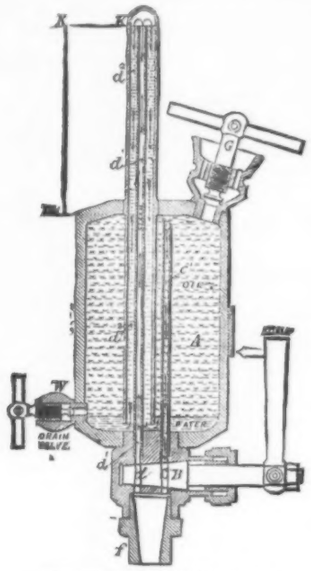
Referring to our engraving, it will be seen that the lubricator consists of a chamber, A, for containing the lubricant, this chamber being furnished at the bottom with a cock, B, and at the top with a filling plug, G. The passage in the screwed union, *f*, provided for attachment to the cylinder or valve chest, communicates with the body of the lubricator by two holes, c^1 and d^1, there being in the plug of the cock, B, two corresponding passages, *c* and *d*. The passage, e_1, is prolonged by a tube which rises to near the top of the oil chamber, A, as shown, while the passage, d^1, is similarly prolonged by a tube which entirely traverses the body of the lubricator, and into the larger tube, K, this latter tube being closed at the top as shown.

The action of the lubricator is very simple. When the plug of the cock, B, is turned so as to open the passages, *c d*, the steam from the cylinder rises through *d*, and condenses in the annular space, d^2, between the tube, d^1, and the outer tube, K. In our engraving this condensation is supposed to have gone on until the annular space, d^2, has been filled with water to the level, K. Under these conditions it is evident that the flow of oil into the cylinder through the passage, c^1, is opposed by whatever steam pressure may exist in the cylinder at the time, while on the other hand there is a tendency to force the oil out of the cylinder, the pressure due to the column of water in the annular space, d^2, plus the pressure of steam on the surface of this water at K. The pressure of steam acting against the inflow of the oil is



IMPROVED ROTARY VALVE GEAR.

thus neutralized, while there remains the effective pressure due to the head of water in the space, d^2, tending to make the oil overflow the top of the tube, c^1, and pass down this tube into the cylinder or valve chest. With the tube, c^1, flowing full, the effective head of water causing the inflow will be practically equal to the whole height of the column in the space, d^2; with the tube, c^1, only partially filled, however, the head just mentioned will be reduced by the weight of the column of oil contained in the reservoir, A. With the chamber, A, empty of oil, but charged with water, the effective head will be reduced to K, *m*, the head, however, being in all cases sufficient to secure a regular inflow.



IMPROVED LUBRICATOR.

The chamber, A, is furnished with a plug at W for discharging the water, when the lubricator has to be refilled with oil, while a scale on the side of the chamber, A, enables the handle of the cock, B, to be adjusted according to the delivery of oil required.—*Engineering.*

THE PROPOSED NEW BRIDGE OVER THE DOURO.

WE have already referred to the new bridge which it is intended should be erected over the Douro to join the city of Oporto with Villanova de Gaïa, and the contract for the construction of which was opened to public competition some time since. The work is not only of considerable magnitude, but presents peculiar features in its general design and mode of erection. It is to be, necessarily, in one span, and will have to be almost necessarily erected without scaffolding. The width of the river at the point of crossing is 525 ft., so that when completed, the arch, if an arched design be decided upon, will be the largest yet attempted, as the clear span will have to be at least 560 ft., or 35 ft. wider than the Maria Pia Bridge, erected some time since by MM. Eiffel & Co., of Paris (*vide* the twenty-fifth volume of *Engineering*). Moreover, the design has to provide for two roadways, one 39 ft. above the level of the water, and the other 197 ft. above, the widths being respectively 19 ft. 6 in. and 26 ft.; the object of these two platforms is to connect the higher parts of Oporto and Villanova, as well as the river bank on the lower land. Ten different designs were submitted to the Bridge Commission at Oporto on the 12th November last. Each scheme was numbered, and presented to the commission in the order of its number. We reproduce sketches showing the general outline of the respective designs, with some general particulars of each, from *Le Genie Civil*.

1. The first design submitted was that of the Société de Construction des Batignolles. The principal feature is a large arch 22 ft. 11½ in. deep at the springing and 26 ft. 3 in. at the center, where the upper member rises above the level of the horizontal girder carrying the upper roadway. The top and bottom booms of the arch are connected by single intersection lattice bars, one set of which are all vertical, and the others inclined parallel to each other from the springing to the center. The towers adjacent to the arch are of iron resting on masonry piers from which the arch springs. The upper horizontal girders rest on columns supported by the arch, and the lower roadway is suspended at six points as indicated in the diagram. The contract price for this design is 95,902*l.*

2. The second design was presented by the Société Internationale de Construction de Braine-le-Comte (MM. Rolin & Co.). The chief feature is an enormous bowstring girder 131 ft. deep, divided into six panels braced with single intersections. The lower roadway is carried on the bottom of this girder, and the upper by a horizontal girder supported by extensions of the vertical members of the panels of the bowstring. The design is inelegant, but the price is moderate, being 75,200*l.*

3. This design was submitted by the Creusôt Company, and bears some resemblance to that just referred to, but is in all respects a more elegant structure. It alone, of all the ten projects, is constructed wholly of steel. The lower portion of the structure consists of open girders with curved upper members; they are 39 ft. 4 in. deep at the end, and 65 ft. 7 in. deep in the middle. The horizontal girder carrying the top roadway is divided into spans of nearly 100 ft. by the vertical standards rising from the top of the lower girder, which is divided into the 12 panels filled with single intersection bracing. Special provision is made for protecting the lower part of the structure against the action of the wind. Amount of estimate 67,600*l.*

4. Messrs. Handyside & Co., of Derby, presented the fourth design, prepared by Mr. Am Ende, of Westminster, and which presents some of the characteristics of the viaducts designed by the same engineer for the Costa Rica Railway (*vide Engineering*, vol. xxix., page 24). The arch is in two parts, jointed in the center, the form of the curve being slightly ogival. The extrados consists of a horizontal line nearly coinciding with that of the upper roadway, and two inclined lines meeting the former nearly midway between the piers and the center; the system of bracing is indicated in the sketch, which also shows the arrangement of the smaller spans of the upper portion, which are framed up with the piers. The two principal of these are wider at the base than at the top, the others decrease in width toward the masonry pedestals. The lower roadway is suspended from the arch by a number of rods. Transversely the whole structure is widened toward the lower part to increase its stability. The estimated cost is 81,200*l.*

5. M. Lecocq & Co., of Hals, Belgium, submitted a curious design which is indicated in the sketch; it is a combination of cantilever, bowstring, and suspension, somewhat difficult to describe. Price 75,000*l.*

6. This scheme presents in all respects a striking contrast to the preceding, and of all the designs is the simplest and most severe. It constitutes an immense parallel girder 157 ft. deep, divided into four panels, each 131 ft. wide; the top and bottom members of the structure, each forming a very heavy girder, carry the upper and lower roadways. The panels are filled with single intersection bracing, the outer pair of struts being of very large dimensions, and carrying the upper girder down to the abutments. This is, as may be supposed, the cheapest of all the designs submitted, the price being only 48,720*l.*

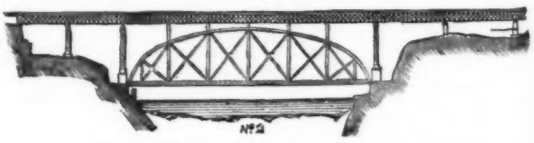
7. This is Mr. John Dixon's project, and presents several novelties in design. The central arch is reduced by means of two huge inclined struts, resting on the abutments, and on each side the arch is extended in cantilevers to the principal piers, which are tubular, and of wrought iron. One feature of this design is the proposal to erect the inclined struts vertically, and then to lower them to their permanent position shown on the sketch. The assumed cost is 94,540*l.*

8. This and the two succeeding schemes are on similar lines—those suggested by the existing Maria Pia Bridge at Oporto. No. 8 is the design of MM. Eiffel & Co., who built that bridge, and is a very elegant looking structure. The arch is parallel throughout, and about 18 ft. deep. The girders forming this arch are spread laterally to afford greater stability. The upper roadway is carried by vertical columns resting on the arch and placed at intervals of about 50 ft., small arches being turned between them. The lower roadway is suspended by a number of rods at intervals corresponding to the uprights carrying the upper roadway. Between the latter uprights, and about midway up the arch, is a system of horizontal strutting, and all the columns are thoroughly braced together, the suspension rods not being braced however. The piers are of iron resting on masonry bases. Estimated cost, 70,400*l.*

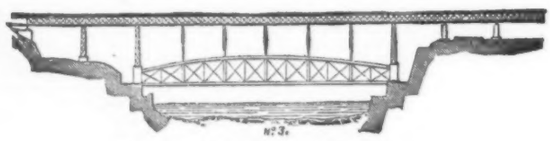
9. This was designed by M. Seyrig for the Société de Willebroeck, and presents the general features shown in the sketch. The arch is deeper at the ends than in the center, 39 ft. 4 in. and 26 ft. 3 in. respectively. The two girders forming it are caused to diverge toward the abutments which carry the main piers of the bridge. The upper girder, parallel throughout, is tangential to the top of the arch, and is supported by it only at three places as indicated. The lower girders are suspended by four systems braced together transversely. These girders, which are parallel, are articulated one to the other in such a way as to receive the advantages of a continuous girder without the difficulty arising from the deflection of the arch and consequent distortion of the lower structure. Price 82,000*l.*

10. Of this design, presented by MM. J. F. Cail & Co., it is only necessary to say that it is an exact copy of the existing Maria Pia Bridge, with the addition of the lower suspended roadway, and that the estimate amounts to 61,212*l.*—*Engineering.*

No. 1.—SOCIÉTÉ DE CONSTRUCTION DES BATIGNOLLES, PARIS.

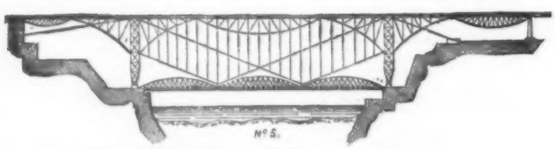


No. 2.—MM. ROLLIN & Co., BRAINE-LE-COMTE

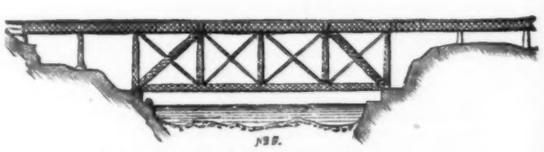


No. 3.—MM. SCHNEIDER & Co., CREUSOT

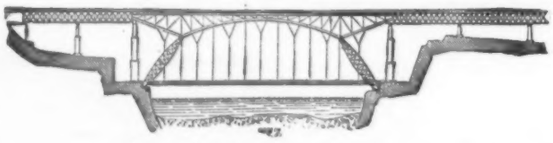
No. 4. MESSRS. HANDYSIDE & Co., DERBY.



No. 5—MM. LECOCQ & Co., HALS, BELGIUM.

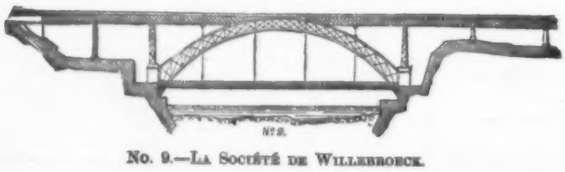


No. 6.—LA SOCIÉTÉ DE FIVES-LILLE



No. 7.—MR. JOHN DIXON, LONDON.

No. 8.—MM. G EIFFEL & Co., PARIS.



No. 9.—LA SOCIÉTÉ DE WILLEBROECK.

No. 10.—MM. J. F. CAIL & Co., PARIS.

DESIGNS FOR THE NEW BRIDGE OVER THE RIVER DOURO, AT OPORTO.

PERSPECTIVE CARRIAGE DRAUGHTING.

By ADOLPHUS MULLER.

THE figure represents an extension-top phaeton on platform springs, the horizontal line being again drawn through the top. This illustration is principally intended to show the manner of drawing an open top. Let all bows and joints be parallel, and even for the smallest points draw all your lines to the vanishing point, A. Lighten the center of the body somewhat more than it would get according to our vanishing point; this will make the distance between the bows more uniform, and impart a certain lightness to the whole which is most desirable in this class of vehicles. Experience also shows that it is well to give to every long vehicle the appearance of a little "drop"—or "rig up," as it is vulgarly called—by drawing both hind wheels a little above the bottom line.

This vehicle might with equal correctness be termed an extension-top cabriolet, as its appearance closely resembles the latter, although in construction it is somewhat lighter than cabriolets are usually made. It has a light, airy appearance, which together with its high wheels, makes it a very desirable country carriage. The wings or fenders extend down to the step, which gives the carriage a more dressy and stylish look, and also prevents the mud from being thrown on the steps.

As will be seen by the drawing, a drop pump-handle is necessary in order to get the job up, so as to use a high front wheel. The body hangs about 30 in. from the ground.

Dimensions.—The principal dimensions are as follows: Width of seat frame, back, 38 in.; front, 37½ in.; width across toe-board, 30 in.; width of tail-bar, 32 in.; turn-under, about 5 in.

The following are the principal dimensions of the front carriage-part: Axles, 1⅛ x 7 in. Track, 51½ in. Beds, 6½ in. high, including iron. Kingbolt set forward 3½ in. Half fifth-wheel, 22 in. in diameter, and iron back bars. Wheels, 35 in. high, including tire. Hubs, 4¾ x 7 in. Spokes, 1⅜ in. light; number of spokes, 10. Rims, 1¼ in. full. Dish, ⅜ in., without tire. Tire, 1½ x ⅜ in. steel. Springs, 1¼ in., steel; 4 plates, three No. 2 and one No. 3 steel; 36 in. long by 7⅛ open, inside; distance between springs, 30½ in.

ancient of their species? There are certainly no nails in doors of good style nowadays; but whether this is due to the extinction of the species or not, I cannot decide.

It seems a simple and easy enough matter to drive a nail, but not one person in a thousand can drive one with the greatest possible effect where considerable skill and judgment are needed to this end. Most mechanics whose peculiar trade requires the frequent exercise of this operation neglect to study the subject properly, and drive a considerable percentage of their nails in an inefficient and useless manner. And amateurs, whose operations are usually upon subjects of the most difficult kind, almost invariably fail, usually doing more harm than good, by splitting the wood and rendering it more difficult for the most skillful to insert a reliable nail. I have counted twenty-three nails driven to repair a wheel-barrow, only five of which did any good at all. All the rest either split the wood or crippled or deflected at the point. And this is not an exceptional case. Examine any article of domestic use that has been repaired with nails by amateurs, and you will probably find that a large majority of them do more harm than good. Yet a little judgment and thought upon the subject would direct us where and how to insert a nail in any difficult case, so as to have the desired effect.

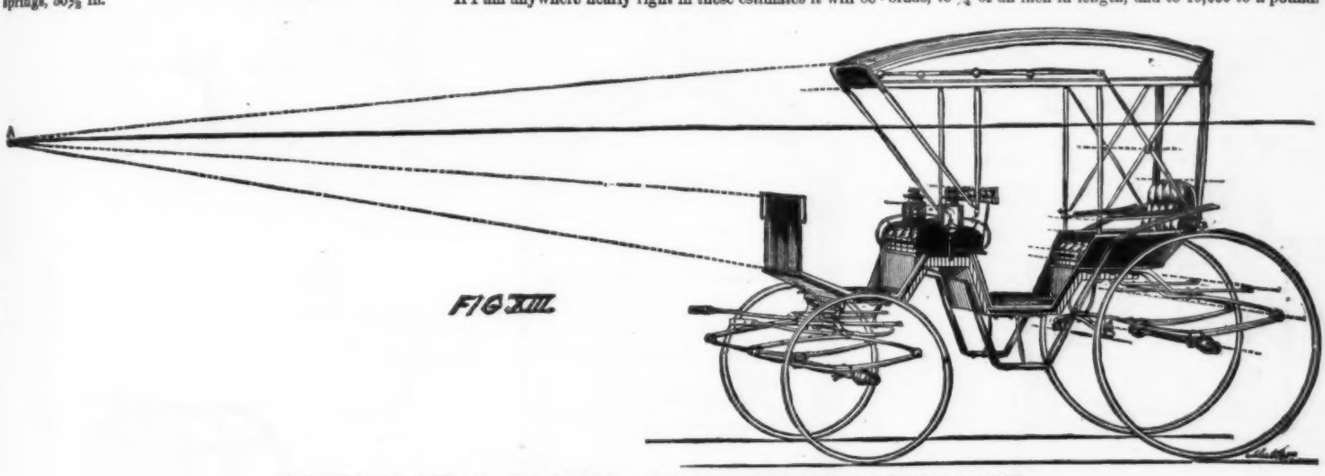
Not long ago I obtruded some unsought advice upon an experienced carpenter, who was vainly trying to insert a small nail effectively into the thin edge of an ornamental pattern to repair a split. The edge being only a quarter of an inch in thickness, the nail refused, in spite of his best skill, to confine itself to the limited section of the wood, but insisted upon protruding itself upon one side or the other. After repeated failures, he reluctantly consented to take a lesson upon the subject, and can now drive a nail under similar circumstances with the necessary precision.

In nailing boards upon timbers, the simplest and plainest of all the various phases of nail-driving, at least one in ten is usually lost by carelessness on the part of the operator, or defect in the nails themselves. And in the more difficult operations, as of box-maker's or joiner's work, a much larger percentage of waste is suffered. In an average lot of window frames, at least one nail in five, or twenty per cent. of all, will be found to be so driven as to be useless.

If I am anywhere nearly right in these estimates it will be is usually worn and rounded, which augments the difficulty greatly. But whatever hammer you use, rub its face vigorously upon a brick or a piece of sand-paper, or upon some sand or gravel upon a board. This will clean the face—sharpen the teeth, as it were—and multiply the chances of an effective impact. By attention to these and other such precautions as common sense may suggest, any one may successfully accomplish the vexatious task of driving a nail so as to do the most good.

Nails are now driven by machinery, in most box factories where sufficient system and repetition exist to make it profitable, one machine doing the work of from ten to fifteen men. The general idea of these machines is as follows: The nails are fed by hand into bell-shaped holes in a revolving disk. These holes are arranged in radial lines, each line with as many holes as there are nails wanted along the side of a box. This disk revolves and delivers the nails into bent tubes, each nail to a separate tube, which delivers it to a kind of a pair of nippers arranged in a row with others. Upon receiving their nails, the nippers advance simultaneously, so as to bring each its nail under a kind of stationary hammer, the point of the nail protruding below the embrace of the nippers. At this point in the operation, the box upon a sliding platform rises until the points of the nails penetrate it to a certain extent, when the nippers relax their hold and recede, the box still rising to receive the entire penetration of the released nails, the stationary hammer acting upon the heads of them meantime. This nails one edge of the box; but all the edges having the same arrangement of nails are finished by a repetition of the above movements. Then, to do the ends, the boxes are transferred to other machines, or the same one can be readjusted when a sufficient number of boxes have been passed. These machines work with rapidity and precision, not one nail in many thousands failing to enter properly.

Self-feeding nail machines are beginning to occupy the attention of inventors with some degree of success. What are technically known as nails range from 1½ to 6 inches in length, and from 800 down to 10 nails to a pound. But the genus extends upward, under the special name of spikes, to 2 feet or more in length, a single one of which will weigh from 6 to 15 pounds; and downward, under the name of brads, to ¼ of an inch in length, and to 10,000 to a pound.



EXTENSION-TOP PHAETON.—SCALE THREE-EIGHTHS INCH.

The principal dimensions of the back carriage-part are as follows: Axles, 1⅛ x 7 in. Track, 51½ in. out to out. Wheels, 47 in. high, including tire. Hubs, 5 x 7 in. Spokes, 1⅜ in. full; number of spokes, 12. Rims, 1⅜ in. light. Dish, ½ in., without tire. Tire, 1⅛ x ⅜ in., steel. Springs, 1¼ in. steel, 4 plates, all No. 2 steel; 38 in. long by 8½ open, inside. Cross-spring, 1¼ in., steel; 4 plates, two No. 2, one No. 3, and one No. 4 steel; 33¼ in. long by 4 in. curve. Distance between springs, 32½ in. The springs are calculated without the weight of the body, under which they would settle about 1¼ in.

This carriage, if made after the above-named specifications, will weigh about 625 lb.

Painting.—Body, chocolate brown; mouldings, black, with single fine line of orange on inside edges. Carriage-part, chocolate, with three stout fine lines of orange.

Trimming.—Use cloth to match, as nearly as possible, the color of the body. Mountings, silver.—*Hub.*

THE DRIVING OF NAILS.

AT the meeting of the Polytechnic Institute of this city, on December 9, Mr. Dudley Blanchard read the following interesting paper on the subject of nail driving:

In writing an essay upon any theme, said he, the author is usually expected to give something of the origin and history of the subject—to go back, at least, a few centuries, so as to get, as it were, a good start, the impetus of which may assist in carrying him over the dryness of the subject, and save him from getting stuck upon the dusty desiccation of practical experience. But of this resort of the hard-pushed essayist I cannot avail myself. There is no open ground behind whereupon to make a run at my subject. There is really no literature upon the subject of driving nails that I can call to mind. Yes, I have a dim remembrance of some vicious Amazon driving a nail into somebody's head, once upon a time; but this I do not consider a creditable example of the mechanical skill of antiquity, and so will pass it by. Perhaps I might take a hint from Dickens' editor, Pott, of the Eatonsville *Journal*, who wrote an essay upon Chinese metaphysics, and read up in the Encyclopedia under the head of D, for driving, and under the head of N, for nails. But attempting to drive a nail encumbered by two heads, in this way, would prove a disastrous failure. There would be no point to the subject. So I will not go to Pott upon the emergency, but gather up what my own recollections afford upon the subject.

The first nails were probably door nails. I infer this from the old adage which describes them as being excessively dead. No other nails are as dead as door nails. Am I not warranted in assuming, therefore, that they are the most seen that here is, in the aggregate, an immense loss, though I have no data by which to estimate the amount of nails used; but the percentage wasted is certainly as high as I have put it. An improvement in nails affecting their driving qualities is beginning to make its appearance, but is as yet treated with coldness and neglect by mechanics. Nails ought to and will ultimately be made chisel pointed. They penetrate easier, drive straighter, and hold firmer than square pointed ones. But the pointing must be done perfectly; otherwise it induces deflection and misdirection in driving. Nails pointed in cutting are quite certain to get enough ruggedness or irregularity at the extreme point to effect deflection, like the rudder of a ship. The pointing, to have the requisite accuracy, must be done upon the filing principle, which involves, however, too great a complication of machinery.

Mr. Blanchard here exhibited a small piece of board a quarter of an inch thick. Into its edge, said he, I have driven eight nails, or rather two-inch brads. Four of them I sharpened with a file before attempting to drive them; the other four I drove in their natural state, as an Irishman might say. Those that I pointed followed the thickness of the board perfectly, while all the others ran out, nor could I or any one else succeed in confining them to the limited thickness.

I would recommend any carpenter's apprentice to make a special study early in his apprenticeship of the art of driving nails right. This question applies, of course, to all branches of all trades: but my reason for specially urging it in this case is that it is usually neglected at the time when it is most important. Nearly every boy thinks that he can drive nails well enough; and by neglecting to correct his hand while his faculties are flexible he acquires a careless habit that follows him through life. Let any youth who expects to do this as a part of his trade study to give his nails the right direction. Let him sight and enfilade them cautiously. He will thus acquire a habit of precision that he will adhere to habitually and instinctively in after life.

If any one not expert at the art has occasion, as most people will some time or other, to drive a nail in repairing something, let him see to it that he selects a good, sound one. Some nails are treacherously defective, and cripple at the first blow. And if it is to be driven into any wood harder than spruce, let him sharpen it like a cold chisel at the point. Almost any house can furnish some kind of a file that will answer for this operation. And let him rub the nail with beeswax. A nail thus prepared will penetrate most kinds of wood without difficulty and has little tendency to split the wood. A hole should be bored when the means of doing so are at hand; but this may be neglected if other precautions are duly taken. A suitable hammer is not always at hand. The face of the typical hammer of amateur practice

The following table shows the length and weight of the usual nails of commerce:

Quality of Nails.	Denomination.	No. in a Pound.	Length in Inches.
Light Common	3 d.	800	1¼
"	3 "	400	1¼
"	4 "	400	1½
"	4 "	288	1½
"	5 "	200	1¾
"	6 "	159	2
"	7 "	120	2¼
"	8 "	92	2½
"	9 "	80	2¾
"	10 "	68	3
"	12 "	48	3¼
"	20 "	34	4
"	40 "	18	5
"	50 "	14	5½
"	60 "	10	6
Box Nails	3 "	560	1¼
"	4 "	440	1½
"	5 "	272	1¾
"	6 "	250	2
"	7 "	176	2¼
"	8 "	140	2½
"	9 "	120	2¾
"	10 "	100	3
Floor Nails	6 "	184	2
"	8 "	100	2¼
"	10 "	80	3
"	12 "	65	3½
Slating Nails	3 "	300	1¼
"	4 "	200	1½
"	5 "	150	1¾
"	6 "	124	2
Fine Finishing Nails	4 "	544	1½
" " "	5 "	480	1¾
" " "	6 "	272	2
" " "	8 "	165	2½
" " "	10 "	100	3

A short discussion followed, during which Dr. Trimble asked to be informed as to the origin of the term "tenpenny nail."

Mr. Stetson, the chairman, ventured the explanation that

"tenpenny" was a corruption of "ten pun-ny," from "ten pun'," meaning ten pounds to the thousand.

Mr. Hudson would only undertake to say that "tenpenny," as applied to nails, was an old English term applied two or three hundred years before the cut nails of the present day were made.

The rational explanation was given by a gentleman, who said that originally, when nails were made by hand, the workmen were paid so many pence per hundred, and in that way the nails got their names, as "fourpenny," "fivepenny," "tenpenny," etc. This explanation, as being manifestly the true one, was greeted with applause.

Mr. McDonough, from California, exhibited a model of a new steam plow of his invention, which greatly interested the savants.

THE NATIVE SILKS OF ASSAM.

By C. G. WARNFORD LOCK.

THE native silks of Assam, known as *Eria* and *Muga*, are the produce respectively of *Attacus ricini*, and *Antheræa assama*, and *Antheræa mezankooria*.

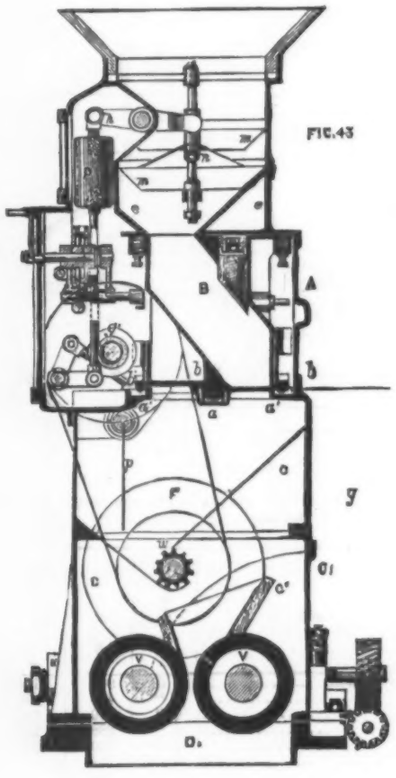
The *Eria* worm is so called from the local name of the castor-oil plant (*Ricinus communis*), on which it is almost exclusively fed. It is reared entirely indoors. The duration of its life varies with the season: in the summer, it is shorter, and the product is both better and more abundant. At this season, 20 to 24 days elapse from the date of its birth to the time when it begins its cocoon, 15 days later the moth is produced, in three days the eggs are laid, and in five more they are hatched, making the total duration of a breed 48 days. In winter, its life extends to nearly two months. Seven breeds are reckoned upon annually. For breeding the natives select cocoons from among those which begin to be formed in the largest number on the same day. Those containing males are recognized by a more pointed end. On the second or third day after the cocoons have begun to be formed they are put into a closed basket and hung up in the house, out of reach of vermin and insects. Twenty-four hours after the moths have been produced the females are tied to long reeds or canes, 30 to 35 to each, and these are suspended in the house. The eggs laid during the first three days alone are kept; they are tied up in a piece of cloth, and hung from the roof till a few begin to hatch; these eggs are white, and resemble turnip seed in size. When a few of the worms are hatched the cloths are put on small bamboo platters, and here they are fed with tender leaves. After the second moulting, the worms are removed to feed on bunches of leaves, suspended a little above the ground, and a mat is spread beneath to catch those which fall. When they have ceased feeding they are placed in baskets filled with dry leaves, among which they form their cocoons. In four days the latter are complete. A selection having been made for the next breed, the remainder are exposed to the sun for two to three days, to destroy the vitality of the chrysalis. The cocoons are next generally put into water containing potash (wood ashes), over a slow fire; when removed the water is gently squeezed out. At other times they are massed together for some days with *amrita* (*Carica papaya?*) or *madhu* fruit. The object is the same in either case, viz., to facilitate the drawing of the silk. The cocoons thus treated are taken one by one, and the silk is placed within the thumb of the left hand, while the right is employed in drawing out the silk. Any inequalities that may exist are reduced by rubbing them down between the thumb and finger; the same process serves for joining on new cocoons. The thread is allowed to accumulate in quantities of about half a pound; these are afterwards exposed to the sun, or placed near a fire, till dry, when they are wound up into skeins. The silk is then ready for the weaver. It is the coarser of the two kinds, and none of it ever finds its way into Bengal.

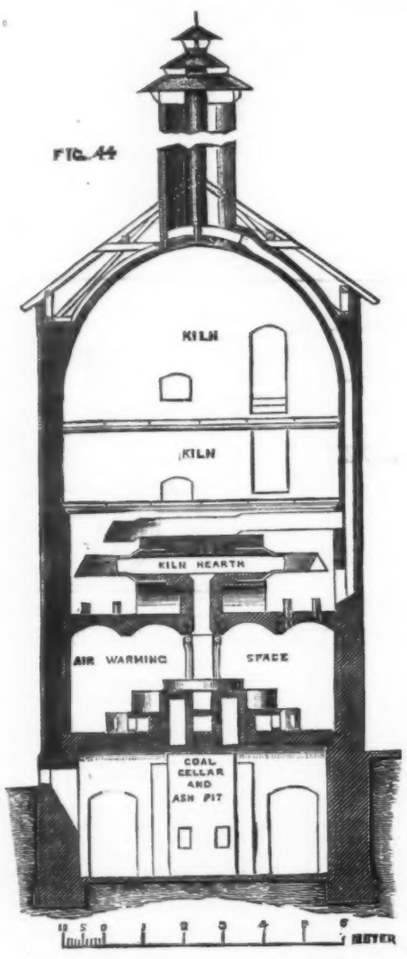
The *Muga* moth is found wild in the jungle, but all the silk produced by it is from domesticated worms. They are reared on trees in the open air. There are generally five breeds in a year, viz., January to February, May to June, July to August, September to October, and November The first and last yield the best crops, as regards both quantity and quality. Constant watching of the tree is necessary. By day crows and other birds pounce upon the worms, and devour them. By night bats, owls, and rats are very destructive. Numbers of the caterpillars are destroyed in the more advanced stages by the stings of wasps, and by the ichneumon insect, which deposits its eggs in the bodies of the worms. The latter thrive best in dry weather, but a very hot sunny day at the moulting time proves fatal to many. Indeed, at this period, rain is considered very favorable; and even thunder storms are not injurious, as they are to the mulberry worm. Continual heavy rains do mischief by sweeping the worms off the trees; but showers, however violent, cause no great damage, the worms generally taking shelter under the leaves with perfect safety. During moulting the worms remain on the branches, but when about beginning to spin they come down the trunk. Bunches of fresh plantain leaves are tied round the trunks, at some height from the ground, in order to arrest their progress. The worms are then collected in baskets, which are put under bunches of dry leaves, suspended from the roof of the house; they crawl up into these and there form their cocoons. The total duration of a breed varies from 60 to 70 days; the period is thus divided: 4 moultings, 20 days; from fourth moulting to beginning of cocoon, 10 days; in the cocoon, 20 days; as a moth, 6 days; hatching of the eggs, 10 days; total, 66 days. The chrysalis, not being easily killed by exposure to the sun, a number of cocoons are placed upon bamboo stages, and covered with leaves, while a quantity of dry grass is ignited below them, and in a short time destroys them. The cocoons are then boiled for about an hour in water containing potash (the ashes of mustard and other plants). When taken out they are laid between folds of cloth. The floss is removed by hand, and the cocoons are thrown into hot water. The instrument used for winding off the silk is the roughest imaginable. A thick bamboo, about 3 feet long, is split in two, and the pieces are driven equally into the ground about 2 feet apart; over the interior projection of one of the knots is laid a stick, to which is fixed, a little on one side, a round piece of plank, about 1 foot in diameter. The rotary motion is given by jerking this axle, on which the thread rolls itself. In front of the vessel holding the cocoons a stick is placed horizontally for the thread to travel upon. Two persons are employed—one attends to the cocoons; the other jerks the axle with the right hand, and with the same hand directs the thread up the left forearm, so that it is twisted in coming down again toward the hand, while the left hand conducts the thread over the axle. The Assamese consider it a good annual return if an acre of trees support 50,000 cocoons, yielding upward of 24 lb. of silk. It must be very profitable, as 1,000 cocoons are reckoned to afford 6 to 8½ oz. of silk thread, selling at 10s. to 12s. a pound. The labor and expense of maintaining a plantation of the trees is very trifling.

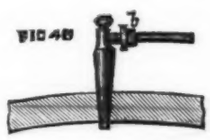
Two kinds of silk are distinguished by the natives as the production of the *Muga* worm—*muga* and *mujankuri*, their difference being attributed to the trees on which the worms are fed; but naturalists have determined a specific difference in the worms themselves, calling the former *Antheræa assama*, and the latter *Antheræa mezankooria*. The *Muga* worms feed chiefly on the *sum* tree (*?Artocarpus chaplasha*; *Tetranthera lanceolata*); *mujankuri*, from those fed on the *adakur* tree (*?Tetranthera quadrifolia*). The latter is whiter and better than the former. Some of the silk thread produced in Sibsagar sells for as much as 36s. a pound. Lakhimpur, in 1871, exported 11¼ tons of *Muga* silk thread, valued at £6,090.—*Jour. Soc. Arts.*

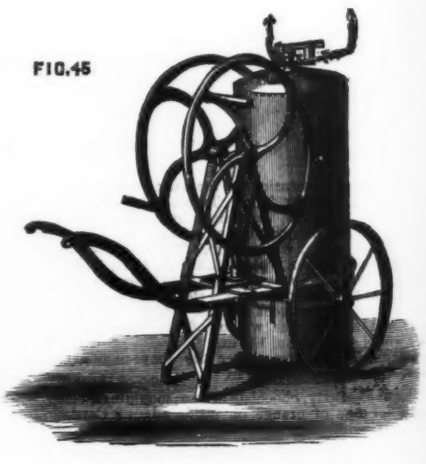
BREWING IN AUSTRIA.

As a specimen of an Austrian brewery, and of the apparatus used therein, the Figs. below illustrate in plan and section the arrangements adopted in a modern establishment. The malt crusher is placed in the loft above the boiling house and fed by an elevator. The malt wagons are fitted with a hopper, and are manipulated on rails, which run from beneath the crusher over the weighing machine, B, to the feed pipe, C, which communicates with the auxiliary mashing apparatus, D, and through it with the mash tun, E. The mash and clearing tun, E, is placed at such a height that the mash and wort can run down into the mash and wort pan, G, by gravity. The stirrer is suspended and driven by shafting, the flues surround the pan to the height of the lowest level of water in practice, and the draught is regulated by a damper. A steam dome, M, with pipe and movable cover for giving admission, completes the pan. The return of the boiling mash to the mash tun, as well as of the boiled mash to the clearing tun, is effected by a centrifugal pump, K, with the necessary pipes, valves, and taps. The pipe by which the mash is brought from the pan to the tun can be turned round to convey the contents, when sufficiently boiled, to the clearing vat. The wort is run from the clearing vat to the reservoir or back, and from there into the inclosed square wort pan. The wort when strained is raised by a centrifugal pump to the cooling back. The average proportion in Bohemia is about 1 bushel of malt to 21·15 gallons of beer. The system of cooling in Austria is much the same as that adopted in England, excepting that the use of ice is, as we have explained in previous articles, more general, and the action more rapid and better for the beer. The wort arrives at the cooler with a temperature of 200 to 208 deg., and is reduced as rapidly as possible to 55 to 65 deg., as the best for commencing fermentation, requiring from six or seven hours to twelve or fifteen—the shorter the better—and as the temperature of the outer air should, if possible, not exceed 50 to 55 deg., spring and autumn are chosen as the seasons best suited for brewing. The amount of ice consumed in the operation can easily be calculated; for 1 lb. of ice requires the heat contained in ¾ lb. of boiling water to melt it; therefore to reduce 5,000 lb. of wort from say 50 deg. to 45 deg., or 5 deg., requires 5×5,000=25,000 deg. of





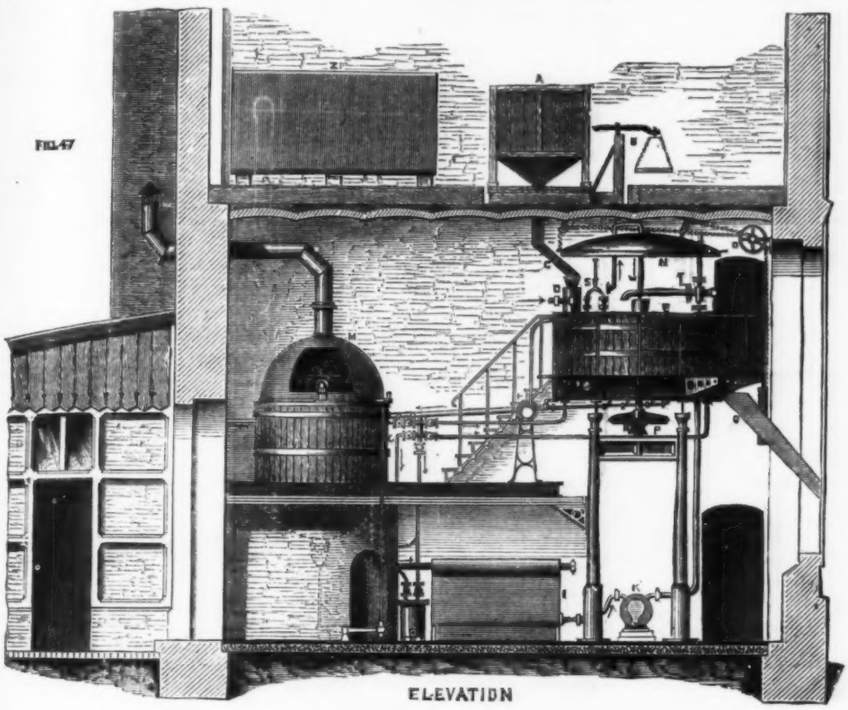




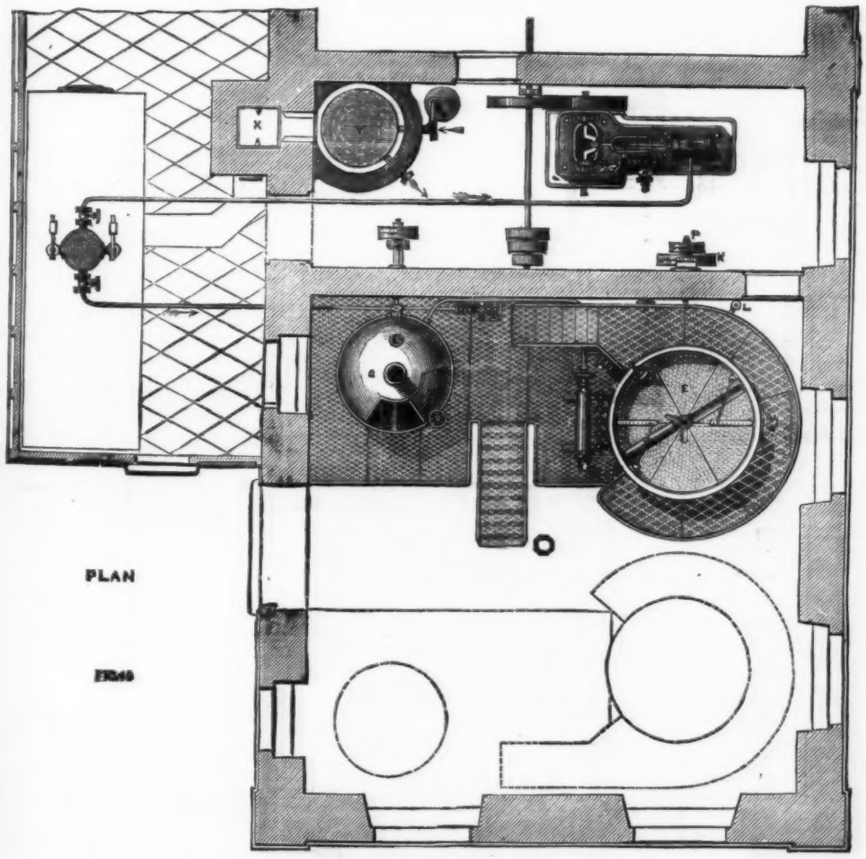
AUSTRIAN BREWERY PLANT.

"cold," and as 1 lb. of ice absorbs about 180½ deg., we get $\frac{25{,}000}{180{\cdot}5}$ deg. = 139 lb., or approximately 28 lb. of ice for every degree; with the improved refrigerators of the present day this amount is materially reduced.

In the illustration below, A is the malt wagon; B, weighing machine; C, feed-pipe for malt; D, auxiliary mashing apparatus; E, mashing and clearing tun with steam floor; F, clearing battery; G, wort pan heated by steam; I, hop boiler; K, pump; L, watering pipe for damping; M, steam dome; N, cover to tun; O, arrangement for manipulating



ELEVATION



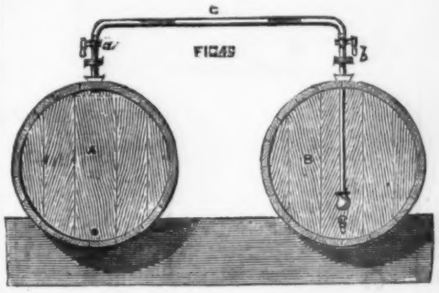
PLAN

AUSTRIAN BREWERY PLANT.

N; P, transmission; Q, door for removing grains; R, valve for running off mash; X, chimney; Y, boiler for warming water; Z, reservoir.

A new method of resuscitating beer that has lost its carbonic acid has been devised, and is coming into use in Austria. The method here adopted specially recommends itself from the simplicity of its application, and from the economical use of the carbonic acid that otherwise escapes from newly barreled beer to give life to the contents of other barrels which have become flat through the loss of this important adjunct to their vitality. As will be seen from the engraving, Fig. 49, the arrangement consists of a short copper pipe, *a*, which is screwed into the bung of a newly filled barrel and allowed to project about ⅜ in. into the interior of a longer copper pipe with a pear-shaped rose fitted through the bung of the barrel in which the beer has become flat, and projecting into the same to about three-quarters of its depth, and of the junction pin, C, whose length depends on the position of the barrels. The internal diameter of the pipes is ⅞ in., and the junctions are made air-tight with pitch. The mode of procedure is as follows: The apparatus is fixed as shown in Fig. 49, as soon as the barrel, A, containing the fresh brewed beer, has been filled to within a short space of the top. Both the cocks, *a*, *b*, are kept closed for from twenty-four to forty-eight hours until the pressure in A is considerably increased; they are then gradually opened, and the carbonic acid escaping from A passes over into the flat beer in the barrel, B, and entering at a considerable depth, is dispersed and absorbed on its way upward. The barrel, B, must be tapped to test the alteration that takes place, and a small quantity repeatedly drawn off to excite a movement of the liquid, and promote the distribution of the carbonic acid. The passage through and absorption of the carbonic acid by the flat beer assists in clearing the latter as the acid is taken up by the liquid, and precipitates particles which would otherwise make the beer cloudy. The barrel, A, must not be filled up, or beer, as well as carbonic acid, will escape into the old beer, and the principle is to give life to old beer and not to institute a new and independent fermentation, which would inevitably follow an admixture of two separate brewings, and prevent the immediate consumption of the resuscitated beer. The experiment can be illustrated by connecting two bottles, as shown in Fig. 50, in which the letters A and B, refer respectively to the fresh brewed and stale beer. The carbonic acid escaping, or as a rule allowed to escape, in the cellar from a barrel containing 110 gallons, is sufficient to resuscitate 1,100 gallons of beer that has lost its carbonic acid, by being placed either between a couple of large barrels containing that quantity, or coupled with ten barrels of the same capacity.

Machinery for Measuring and Weighing Barley, Malt, etc.—A reliable machine of this kind is a positive necessity in every brewery, whether it be required by the excise authorities—as in Germany—or merely be used as a check on the store books. Hitherto the apparatus most in use has been the one shown in Fig. 48, constructed by Messrs. Engelhart & Co., of Fürth. It consists of a revolving drum, B, in a cylinder, A, with the gauging vessel running at an angle through it, which alternately, at opposite sides, is open at the top to the hopper, composed by the cover plates, E E, and at the bottom to the hopper, F, which leads to the crushing rollers, V. The drum, B, pivots on the spindle,



APPARATUS TO REVIVE BEER

b^1, in the step, *a*; and turns in the ring, a^1, which is lined with *lignum sanctum*. A similar packing at the top with set screws prevents any escape of dust. The cylinder, *d*, worked by the set screw, d^1, in the drum, B, is for regulating the contents of the gauging vessel according to the specific gravity of the grain. The drum is driven by a worm wheel on its outer edge, and the pinion, G, which is connected with a pulley, H, loose on the spindle, I^1, driven by the sheave, I. When the lever, e^2, is free it engages in the pin, e^4, by means of the fork at its extremity, exerts a pressure, of the eccentric attached to H, on the ring, e^3, and sets the apparatus in motion. When, however, the lever, e^2, is held fast by the pulley, the eccentric, *e*, is not brought into contact with the ring, e^3, and the pulley, H, and the pinion, G, run loose on the spindle and the apparatus is out of gear. The two funnel-shaped copper rings, M M, with the intervening cone, N, are placed in their several positions to produce an equal pressure of the malt on the gauging vessel. The quantity of grain is recorded by clockwork. There is an automatic arrangement to prevent a more rapid influx of malt than the rolls can crush. From five to ten gaugings per minute can be worked, and as the contents are either 5 or 10 liters, according to the size of the apparatus, from 40 to 160 bushels can be measured per hour.

Apparatus for Filling Beer from the Store Vats into the Transport Barrels.—The apparatus consists of an air chamber, as shown in Fig. 45, into which air is pumped until a pressure of four atmospheres is obtained. The air vessel is

EXPERIMENTAL APPARATUS FOR REVIVING BEER.

then put into communication with the store vat by means of a tube, in which the pressure is reduced by a regulator to one-half one atmosphere, and a small cock, Fig. 46. The tap is then opened in the vat and the beer driven by pressure of the air into the barrels without coming in contact with the atmosphere. The advantages are that no carbonic acid is lost; a vat can be left half empty without risk of damage, while the remainder of the beer is under pressure, and if pressure sufficient be applied the operation can be conducted in a chamber above the cellar, as the less the latter is disturbed the better for the beer. The question is exciting a good deal of interest whether this manipulation is injurious to beer as an article of consumption or not. The theoretical brewers, *i. e.*, the professors of chemistry, whose vocation it is primarily to induct the rising generation into the mysteries of the different arts of manufacture, condemn the practice as prejudicial to health. The practical brewers, on the other hand, whose very existence as manufacturers depends on their supplying the public with good and palatable beer, defend the practice with equal warmth. The result is still undecided, but some of the legal officials seem inclined to support the chemists, and are trying to enforce their condemnatory verdict. The use of this apparatus in ordinary beer restaurants has already been forbidden in Brünn, so that in public-houses where the consumption is not rapid the public are condemned to satisfy their thirst with the flat remainders of long tapped barrels, or the landlord to the loss of a considerable portion of their contents.

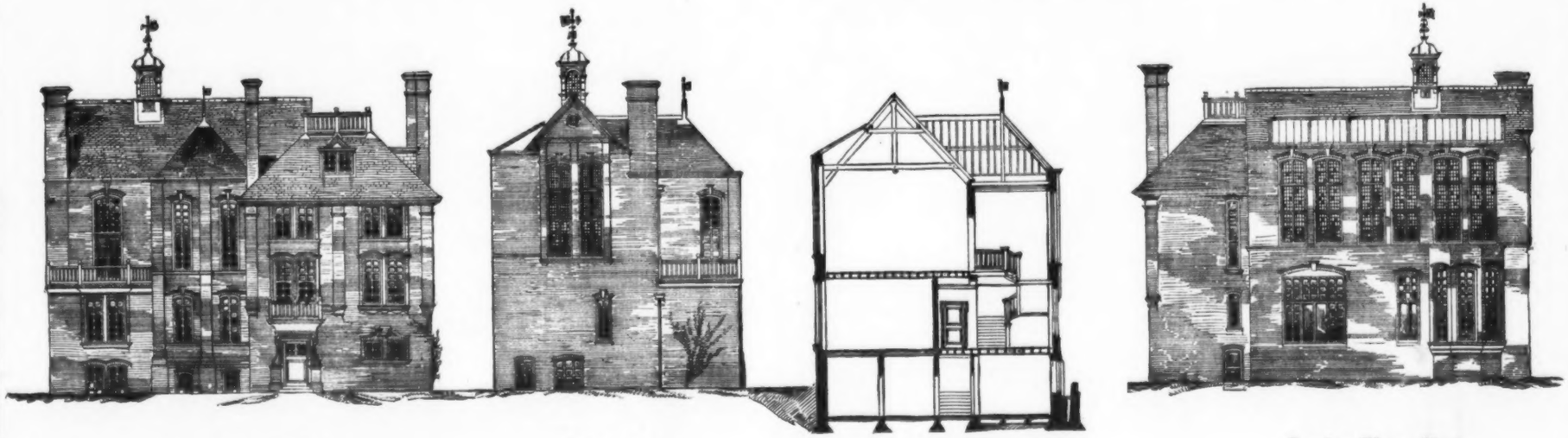
Kilns.—Various forms of kilns are used; one of the most

ARTISTS' HOMES N° 9 · House and Studio Holland Park KENSICTON for S. LUKE FILDES Esq^re A·R·A·

GENERAL DRAWINGS

Scale of feet

R. NORMAN SHAW R.A. ARCHT



Front · Elevation·

West · End

Section of Studio

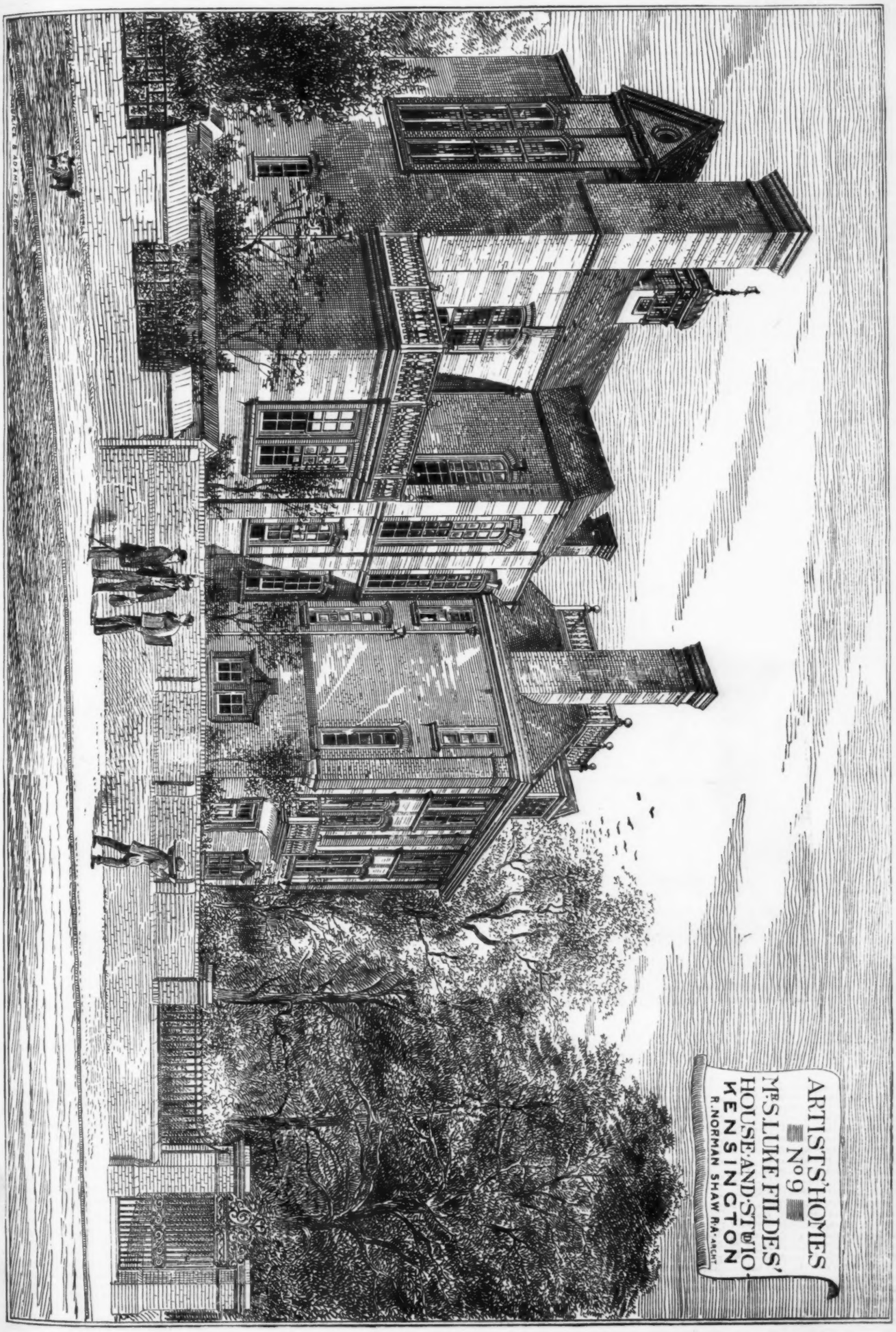
Back · Elevation·

First Floor Plan

Ground Plan

Basement Plan

Roof · Plan ·


ARTISTS' HOMES
No 9
MR. LUKE FILDES' HOUSE AND STUDIO
KENSINGTON
R. NORMAN SHAW R.A. ARCHT.

improved, on the system of Herren T. W. Engelhart & Co., is shown in Fig. 44. Concerning this kiln we shall have more to say. The general features of its construction are shown so clearly in our engraving that little description is necessary.—*The Engineer.*

ARTISTS' HOMES.—No. 9.

MR. S. LUKE FILDES' HOUSE.

THIS house and studio stand at the top corner of the Melbury Road, Holland Park, Kensington, and were erected some three years ago by Mr. Lascelles, from the designs of Mr. R. Norman Shaw, R. A. Our illustrations on the two previous pages give the general plans and elevations of the house, with a perspective view of the building. The house is placed about midway on the plot on which it is erected, so that a front garden of moderate size is obtained. Entering an almost square and hospitably-furnished hall, the visitor reaches the level of the ground floor proper, the various levels arranged throughout the house being so managed that the kitchens are hardly below the outside ground level, while a convenient distribution of rooms very easy of access is secured. Taking it as a whole, Mr. Fildes' house is more of a residence or dwelling house than some that we have illustrated, and although the studio is, perhaps, larger than many, yet it does not overpower the rest of the house. The inner or staircase hall is some five steps above the outer hall, and is on a level with the serving and reception rooms, of which the dining room is entered first. Here a massively-wrought chimney piece in walnut, made by Messrs. Jackson & Sons, is to be noticed. India rugs and carpets, in quiet reds, grays, and browns, suit the salmon or brick-red coloring of the walls, and carry out the brown-painted window frames and doors. A serving door is well planned next the back staircase. The drawing room is a fine apartment, having a deeply-projecting bay window running almost the whole length of the room from the floor line. A balcony outside provides a means of access to the garden at the rear of the house, which overlooks Holland Park, and Mr. William Burges' garden adjoining. A spare bedroom is placed next the drawing room, but an opening between these two rooms is contemplated, so that both may be thrown into one when desired. A moulded and foliated mantelpiece in white well suits the drawing room. The main staircase affords a graceful approach to the studio. The long narrow windows give height and dignity, while the easy rise of the stairs themselves leaves nothing to be desired. The studio is forty-three feet long by twenty-four wide, and has windows on all four sides, with a series of toplights as well. The several lights to be obtained from these windows are completely under the control of the painter. These blinds, which are made of dense moleskin stuff, are hung on a double series of cords and pulleys, so that they may either be drawn up from the bottom or lowered from the top of the windows, and by this simple contrivance, a high, middle, or low light can at once be arranged. The skylights are shut by running shutters, and the whole contrivances in this respect are so complete that total darkness would be the result if all the blinds were closed. The large window at the east end is eventually to be built as a means of communication with a glass house, which will occupy the internal corner on plan at this end of the house. For glass house intended to be used for outdoor effects, a sheltered position like this is most desirable, because, if placed open to a south aspect in summer time, the heat and glare of the sun render the glass house useless for painting purposes. An angle fireplace, from the special designs of the architect, is cosily arranged in the studio next the window opening on to the balcony in front of the house, but the heating of the studio is provided for by means of hot-water pipe coils worked from a compact vertical boiler placed in a heating chamber in the basement. The nurseries are on the first floor, and the servants' bedrooms are contrived on the top floor. The kitchen and offices are in the basement, and a "look-out" is shown on the roof plan. The material used for the wall is red brick, and red tiles are employed for the roofs. An old wrought-iron seventeenth-century gate from Highgate has been erected at the entrance to the forecourt.—*Building News.*

CARVED PEDESTAL LIBRARY TABLE IN ITALIAN WALNUT WITH MARQUETRY IN THREE COLORS. DESIGN OF IHNE AND STEGMULLER, BERLIN.—MADE BY E. LANGE.—*From the Workshop*

BETHNAL GREEN MUSEUM, LONDON.

By F. T. ASCHMANN.

DURING a short stay made last summer in London my time was mostly employed in visiting the various museums for which that great metropolis is so justly celebrated. They all contain, to a greater or less extent, many objects and illustrations of various processes of interest to the chemist, and months might be profitably spent in studying them.

Of all the collections which I visited, I found none more interesting than the Bethnal Green Museum, a branch of the South Kensington. Being intended especially for the benefit of the poorer class, it is situated in a somewhat out-of-the-way portion of the city, and is, therefore, rarely visited by tourists or even by the better class of Londoners themselves. I will endeavor to show you, however, that it is well worthy of a visit on the part of all desiring information.

The museum, a handsome red brick building, is situated in Victoria Square, and was opened in 1872. A part of it, especially the upper galleries, is devoted to loan collections of various kinds, principally of art objects. The rest, comprising the first floor and the basement, is occupied by permanent collections, of which the most important are of specimens of food, of animal and vegetable products, of practical entomology, and of the utilization of waste products.

The food collection owes its origin, in 1857, to Thomas Twining, Esq., and has since then been perfected by various chemists, among others the late Dr. Lankester.

The foundation of the animal and vegetable product collection was laid in 1851, at the end of the Great Exhibition, when all the material from the various countries was united as far as possible. These collections are all arranged in a very popular way, and numerous labels and full descriptions accompany the specimens.

During the day and a half I spent at the museum I was able to take many interesting notes, and will endeavor to give an idea of the various things to be seen. Of course these can only be passed in rapid review, most attention being given to those with which we are least familiar.

On entering the museum and turning to the left, we have before us the food collection. First we notice a large assortment of grains and legumins—wheat, barley, oats, rice, millet, maize, peas, beans, and lentils being largely represented. Among others of curious shape and different sizes are the black beans, or "friziles," the principal food of the natives of Central America and Yucatan, who make a kind of flour from them. Peas, grown from seed said to have been found in an ancient Egyptian monument, are shown, as are also various varieties of the chick pea (*Cicer arietinum*). These are used especially in Spain and in the East. They are prepared generally by parching. "Parched peas are as common in the shops of Eastern countries as biscuits are in Europe." Under the head of maize, or Indian corn, I found one of those balls of pop-corn candy sold here quite frequently. It is evidently regarded as a great curiosity, for it carried the following label: "Poppe corn, prepared by heating grains of maize over a bright fire until they burst. Is an important article of diet in the U. S." Next come the starch-producing plants and their products. The arrowroots are represented in great variety, as are also sago, tapioca, and rice starches. "Pithena" is the name given to a preparation from sago and potato starches. "Salep" is obtained from the *Orchis mascula* of Arabia. Starches from the plantain, banana, chestnut, yam, sweet potato, canna, mandioc, and various other locally important plants, are shown. Very interesting are the cassava cakes, from West Africa. These "foo-foo cakes," as they are called, come from Sierra Leone, where the cassava is a very com

mon article of food among the negroes who come from the Niger district. The balls consist of the grated root dried over the fire. In using them, they are rubbed down thoroughly, and then slowly stirred into boiling water until it becomes a thick dough—so thick, indeed, that it may be lifted bodily out of the pot—having the appearance of arrowroot, with innumerable particles of fibrous matter intermixed. It is eaten with palver sauce or pepper-pot, each mouthful being made into a ball, which is dipped half-way into the sauce." The preparations that may be obtained from the potato alone are very numerous, about thirty-five different ones being on exhibition.

Bread in all its varieties is largely represented. "Pungapunga" is a New Zealand native bread made from the pollen of the *Typha utilis*. In times of scarcity, birch bark and even diatomaceous earth, the Bergmehl, was used for making bread; and in Paris, during the siege, the bread served out to the suffering inhabitants could not have been much better, to judge from a specimen exhibited. Cakes from Tuscany, made of chestnut flour, seem to be very nourishing. Subjoined is the analysis:

Water	14
Flesh-formers	8·5
Starch	31
Dextrin	23
Sugar	17·5
Fibers, chiefly cellulose	3·5
Mineral matter	2·5

As a historical curiosity, biscuits baked in commemoration of the jubilee of George III. are shown. Charcoal biscuits for dyspeptics, biscuits from sago, gluten biscuits, and biscuit powder are a few of the varieties.

Sugar from all parts of the world, from various sources, is here shown to perfection. The variety of products besides sugar furnished by the beet root is highly interesting, including, as they do, molasses, vinegar, empyreumatic oil, alcohol, salts of soda, potash, and rubidium, residue for manure, cinders for making glass, exhausted pulp for making paper, etc. The sugars other than cane are:

Beet root sugar—Germany, France, etc. Millet sugar—Spain, Senegal, India. Cocoanut sugar—Ceylon, India. Date sugar—India. Maple sugar—America. Palm sugar—India, Java.

Preserved fruits, often very curious, and sugar confections of every kind, and from every country, are shown in great profusion. Rose-colored honey is produced by artificial feeding of the bees. Wild honey from India is quite black. On being fermented, honey furnishes the mead, or hydromel.

Butter and cheese are very important food products the world over. Ghee, or Indian butter, is mostly made from the milk of the buffalo, while the Esquimaux prepare their cheese from the milk of the reindeer. The South American Indians make and extensively consume a gourd-shaped butter-cheese, the outside of which is built up of cheese, while the interior is filled in with butter. The Chinese prepare a kind of cheese from the pea and bean, which vegetables contain vegetable casein, or legumin. This legumin is extracted by boiling with water, and, after precipitation with an acid and pressing, it is allowed to ripen, furnishing cheese. Dried curds from India, also rennet from the stomach of the camel, are shown.

In this connection I may mention the Irish bog butter, of which a splendid specimen is on exhibition. This is a peculiar fatty or resinous body, found at a considerable depth in the peat bogs in the West of Ireland. It is supposed by the common people of the district to have been ordinary butter, hidden away ages ago by the fairies, or hastily buried by smugglers. Even the label on the specimen at the Bethnal Green Museum says that, "through the action of water upon it for many centuries, this butter has been reduced to a mixture of palmitic, stearic, and oleic acids, the glycerine and butyric acid having been almost completely removed." Mr. John Plant has shown it, however, to be a perfectly natural production, arising from the decomposition of the vegetable matters forming the peat, and belonging to the large family of mineral resins or hydrocarbon compounds.

The exhibit of the various alcoholic beverages is very extensive, and both interesting and instructive in many ways. In England wine is made from the grape in small quantities; from raisins; black, white, and red currants; gooseberries, raspberries, oranges, cherries, plums, elderberry, ginger, cowslip, etc. In fact, alcohol may be produced from almost anything, and a few of the most remarkable varieties of it are from peaches, Jerusalem artichokes, sugar, millet, locust bean, apricots, cider, etc. Liquors are also in great variety. Beer is, however, the great drink of England, and it is said that three and four-ninths gallons of alcohol are consumed yearly by each person there in this form alone, while one and half bushels of barley are necessary to produce that amount.

The other stimulants are in great abundance, and their study would fill a book of itself. I counted twenty-four substitutes for tea alone in the museum, while coffee and tobacco showed a corresponding amount, not to speak of the adulterations. These adulterations of the narcotics, as well as those of the spices, which are fully represented, are shown in a very extensive manner, and occupy several cases.

Insects are not eaten at all with us, the most important substance used as food which we obtain from them being honey. In many parts of the world, however, they are used to a greater or less extent. In the East and West Indies, and in Brazil, the natives eat the larvæ of beetles belonging to the genera *Calandra* and *Passalium*, the species of which feed on palm trees. The larva of the stag beetle is eaten in Rome, and the cockchafer is enjoyed as a tid-bit by the inhabitants of some parts of Europe. In Syria, Arabia, Egypt, and Abyssinia, various kinds of locusts (*Gryllus*) are eaten, and esteemed as a great luxury. The Bushmen of Africa and the Indians of America eat the so-called white ant. A species of the common ant (*Formica*) is eaten in this country. The chrysalis and larvæ of butterflies and moths are relished in New Holland, California, and Peru, by the natives, while the larva of the silkworm is esteemed as a luxury in China. In the preparation of the latter, they are taken from the cocoons from which the silk has been unwound, and, after being roasted in an oven, are served up with soup. The chemistry of the insect kingdom has only been imperfectly investigated. It appears, however, that the flesh and the eggs of insects are composed of the same substances as those found in the higher animals.

There are many other equally interesting food products which it would be interesting to discuss in detail, but which must be passed over. Such are the oil and fat producing plants and animals, the various nuts used all over the world, birds and mammals used as food, edible birds' eggs and nests, food products from China and Japan, etc.

I must, however, speak of an important feature of the collection which gives to it its popular character. This is a class of specimens which illustrates, by what may be termed *displayed analysis*, the chemical composition of many individual food materials. They are shown in several rows of cases, which are divided into compartments, each of the latter being devoted to the substance under consideration, such as meat, milk, potatoes, etc. To take an example. Let us suppose that the chemical composition of meat is to be displayed. A pound of it, represented in the case, on account of its perishability, by an excellent wax model, is first shown; then follow in convenient vessels the exact amount of the different constituents, such as water, fat, fibrin, salts, etc., to be found in the meat. As this same plan is followed with a great number of substances used as food, the collection allows of a very good comparison between them, and gives a very excellent idea of their chemical composition.

In conclusion, I may express the hope that since an exhibition here in 1883 is now assured, steps will be taken to collect and unite in a suitable building a collection similar to that in the Bethnal Green Museum, thus affording the inhabitants of New York an opportunity for improvement equal to that given to those of London at the end of their Great Exhibition in 1851.—*School of Mines Quarterly.*

REVERSAL OF THE IMAGE.

GELATINO-BROMIDE plates have a remarkable tendency to produce images in which the lights and shades are reversed—that is to say, a positive instead of a negative, or *vice versa*. The conditions under which this reversal takes place are various, and are not at present well understood. In this article we do not intend to in any way recapitulate what has been written on the subject of reversed images, but rather propose to jot down some few observations in order that other investigators may have an opportunity of carrying out experiments side by side with ourselves, the general goal being the elucidation of a subject which is at present but little studied. It is very well known—and has been known for many years—that an unduly long exposure will often lead to a reversal of the action of light, whether a wet plate or a dry plate is concerned.

It is not, however, so generally known that an extremely short exposure will often lead to the production of a reversed image on a gelatine emulsion plate; but, in order to favor the development of the reversed image rather than the normal one, two conditions must be fulfilled. The first of these is the absolute clearness of the plate as far as regards previous action of light, or any other agencies which might lead to a general reduction of the bromide of silver contained in the film. The second is the use of a developer containing an unusually large proportion of ammonia, together with a moderate quantity of pyro, and a little or no alkaline bromide. Such a plate as that above specified, if exposed about the twentieth of that time which one might regard as a normal short exposure, will often yield a transparency instead of a negative, if development be carried on with a maximum of ammonia, but little pyro, and no bromide. Such transparencies are often of more or less composite or hermaphrodite nature, those parts which have received the maximum of lighting being opaque, those which have been acted upon by a much smaller proportion of the luminous rays being clear and transparent; while the portions of the sensitive surface which have received the minimum of light present the same degree of opacity as those which have received the maximum of action.

The above observations naturally suggest the idea that in the case of ordinary gelatine plate work, we are, in reality, producing our negatives by the reversed action of light, and giving an exposure, perhaps twenty—or more—times as long as would suffice to produce the first impression—this first impression being a positive picture. This surmise bears with it visions of glory and triumph to those who delight in securing pictures of express trains, bursting shells, and such like objects; but it also has a dark—ay, a very dark—side.

Such a condition of things would be equivalent to increasing the sensitiveness of the present plate, twenty, thirty, or, more likely, a hundred—times; and the question arises, how are such plates to be prepared and worked? Dark rooms would then have to be dark indeed, and it is difficult to imagine the possibilities of preparing emulsion and coating the plates in the obscurity which would then be necessary. Then, again, the shutters of our present dark slides and the walls of our cameras would be far too thin to exclude the minute trace of light calculated to impress plates intended for the production of what we may provisionally call *primary positives*. The shutter of an ordinary dark slide, usually made of mahogany, about $\frac{1}{4}$ of an inch thick, is quite inadequate to protect the usual gelatine plate against the full rays of the summer sun, as one may easily demonstrate by placing a negative and plate in a slide and exposing to sunlight through the shutter.

We shall probably return to the subject of reversal next week, but just remark that in all ordinary cases of gelatine work, a positive image is developed simultaneously with the usual negative image; this positive image being distinctly visible at the back of the plate before fixation—and indeed after fixation, although it is not so obvious to an observer unaccustomed to look for it.—*Photographic News.*

JOSIAH TIMMIS SMITH, C.E.

IT is remarkable that while all the great inventions that have revolutionized the old or created the present steel trade were made in England, this country has been indebted for them to gentlemen of foreign origin. It is well known that the inventor of the open-hearth process is a German to the manner born; but it is not so generally known that the inventor of the Bessemer converter is descended from a family of Breton origin, and that his father was engaged in the Mint at Paris at the time of the French Revolution of 1793. Moreover, neither of these gentlemen had any previous connection with the steel trade. What English genius and resources have done, therefore, has been to apply those inventions to the development of the trade. They have been, not the creators, but the foster fathers of these great inventions. In this capacity no man occupies a more prominent position than Mr. J. T. Smith, the manager of the Barrow Hematite Steel Works, which are the largest of their kind in the world. Nor is there any one now actively engaged in the steel trade that can boast of longer ancestral connection with it. The family, of which he is now the living head, have been leading magnates in the trade for upward of 200 years. One of his ancestors, Nathaniel Robinson, was Master Cutler in 1666; his great-great-grandfather, John Smith, was Master Cutler in 1732; the name of his great-grandfather, Henry Smith, was included in the original charter of the Cutlers' Company; and his own father was Master Cutler in 1797. The Cutlers' Company, though only a local body, representing the steel trade of Sheffield, was till lately the most influential and respected representative of that trade. Now, however, the steel trade of our day is represented by the Iron and Steel Institute, whose members are located in all parts of the civilized world. It is probable that this institute will hold its autumn meeting next year in Sheffield; and if so, it will be a remarkable coincidence that Mr. Smith, whose ancestors successively occupied the highest position that the steel trade of their day could confer, will then occupy the highest position in the trade of our day—the Presidency of the Iron and Steel Institute.

Born at Duckmanton Lodge, near Chesterfield, in 1823, Josiah was the eldest son of Benjamin Smith, and was well educated and trained from his youth in the rudiments of the trade which was regarded as the hereditary vocation of the family. His father's long and honorable connection with the Iron and steel trade of South Yorkshire and North Derbyshire offered exceptional facilities for this early training. In 1840 he went to the Dundyvan Works, near Glasgow, where he was under the tuition of Mr. John Wilson, who was then considered one of the greatest authorities in the trade. He remained there four years, and then, returning home, was for some years associated with his father. With the view of further extending his knowledge of the trade, he determined to study Continental methods of manufacture. He accordingly traveled on the Continent, and having the good fortune to get an introduction to the late M. Schneider, he was allowed to remain for many months at the Creuzot Works, and was there afforded every opportunity of mastering the details of the French processes of that day. On his return to England he became associated with Mr. Samuel Blackwell, whose premature death a few years afterward was a heavy loss to the metallurgy of the Iron trade. Mr. Smith continued in Staffordshire for some years managing iron works either in conjunction with Mr. Blackwell or on his own account. His advice and services were also in request as an engineer; and it was in this latter capacity that he became acquainted, in 1859, with the firm of Messrs. Schneider, Hannay & Co., of Barrow, who a few years previously had become possessed of what proved to be the richest hematite mine in that district, and who had then resolved to build blast furnaces near the mines. Till then the whole of the red hematite raised in Furness (the district around Barrow) was exported, mostly to South Wales and Staffordshire. Messrs. Schneider and Hannay selected Mr. Smith to design and carry out the iron works which they determined to erect at Barrow, then a small fishing town, deriving considerable benefit from the shipment of the minerals of the district. In these circumstances Mr. Smith left the Midlands in 1860, and settled in Furness.

The district in whose industrial development Mr. Smith henceforth played an important part has since then made marvelous progress. In 1861, Barrow had 4,000 inhabitants; in 1871, 18,000, and now, it is estimated, 45,000. In 1867 Mr. Gladstone said of it that for combination of natural advantages afloat and ashore, it probably would not be practicable to find a match for it in any portion of this country. "We have had," he said, "in other portions of this country, especially within our own generation, instances of progress so extraordinary as to outstrip all past European examples and almost to seem to defy the future; but I am sure the whole circle of productive industry and trade cannot produce a picture similar to the growth of this town."

The great steel works, which Mr. Smith had first to construct, and has subsequently managed, were the foundation of this English Chicago. At first four blast furnaces were erected. No. 1 and 2 were blown in on the 19th October, 1859; No. 3 in January, and No. 4 in December, 1860. These were so successful that in 1861 Nos. 5 and 6 were built and blown in; Nos. 7 and 8 in 1862; and Nos. 9 and 10 in 1863 and 1864. There are now sixteen blast furnaces, fourteen of which are built in a single row. In 1865 what was then considered a bold experiment was entered upon.

The Bessemer process was then in its infancy; but it had been so far successful in the two or three works which were then working it that Mr. (now Sir) James Ramsden projected a scheme for building steel works at Barrow. The plans were matured in a few months, and in March, 1865, the Barrow Steel Company was formed. The list of shareholders was very limited, the chief being the Duke of Devonshire, the Duke of Buccleuch, and Messrs. Schneider and Hannay. To explain the interest the two dukes took in the scheme, it should be mentioned that the Duke of Devonshire possesses large estates near Barrow, and that the Duke of Buccleuch is lord of the manor over the greater part of Furness, thus giving him manorial rights over many of the richest mines. As originally designed, the steel works were only one-third of their present size; but before the original design was completed and in working order, an important change was made in the character of the company. Its constitution was altered, and its capital largely increased, though the list of proprietors was not enlarged. Under these circumstances the firm of Schneider & Hannay ceased to exist on the 1st of January, 1866, and the whole of the iron and steel works became the property of the Barrow Hematite Steel Company. The Duke of Devonshire—the only duke in England who has been chancellor of five universities—is chairman of the company. As already stated, the works are the largest of their kind in the world; and the important services that Mr. Smith has rendered in their construction and management may be inferred when we state that, although the director-ate is wealthy and influential, he is the only practical iron-master and metallurgist connected with their management. He has not only been the moving spirit in all their operations; but he has had to examine and adjudicate upon all the successive improvements or innovations in the trade for determining what new features should be introduced at the works from time to time.

The Barrow Iron and Steel Works have now an annual production of 300,000 tons of iron—one-twentieth part of the whole production of the United Kingdom last year; and over 100,000 tons of steel—one-eighth of the total production of the United Kingdom. The company's own hematite mines yield 400,000 tons per annum. The Park mine, which is one of the largest hematite mines in the kingdom, has been worked for over a quarter of a century; and the Stank mine, which is the deepest and also one of the largest in the district, was discovered while boring in search of coal. No suitable coal, however, is found in that district, and therefore their coal has to be carried from Yorkshire, West Lancashire, and South Wales, where they have large collieries. A full description of these splendid works would include an account of nearly every great improvement in the trade during the last twenty years. The furnaces

A MILITARY TOURNAMENT; SWORD VERSUS LANCE.—FROM A DRAWING BY JOHN CHARLTON.

originally built were 45 feet in height, and later ones were built as high as 80 feet; but after a series of elaborate observations as to the working, and calculations as to the economy of different dimensions, a height of 62 feet was selected as the best for smelting hematite; and accordingly the furnaces were reconstructed on that model between 1870 and 1872. One ton of coke and 7 cwt. of limestone are used for every ton of iron produced. The blast is heated by stoves of different descriptions to a temperature ranging between 900° and 1,000° Fahr. There are altogether twenty blast engines, and the house in which eight of them are fitted up, with room for two more, is said to be the largest engine house in the world. The furnaces are fitted with the bell and hopper apparatus for the purpose of utilizing the waste gases, which are sufficient to heat all the boilers and hot air stoves without any other fuel, besides furnishing a large quantity of steam for the engines of the steel works. For supplying steam to the twenty-one blowing engines there are ninety-eight boilers, all fired by gas. The steel works are about 200 yards from the iron works. The Furness Railway runs between the two departments, and a wrought iron bridge spans the whole of the intervening space and connects the different departments. In that span a range of Coppée-coke ovens, thirty in number, have been built. The steel works are contained in three parallel sheds, which are from 80 feet to 105 feet in width, and from 735 feet to 875 feet long. The Bessemer converters are all situated at one end of the three sheds, the steel as it is manufactured into forgings or rails progressing toward the other end, where the articles are finished and loaded. Between 1872 and 1876 there were eighteen converters at work, and that was the largest number ever erected at one works; but owing to the improvements and expedition effected in the Bessemer process the company now find ten converters sufficient to produce their average quantity of steel—from 2,000 to 3,000 tons a week. The pressure of the blast is from twenty-one to twenty-five pounds per square inch, and the average time of blowing is twenty minutes. The accessory machinery consists of two cogging mills, three rail mills, and one merchant mill. Rails are the chief manufacture, but considerable quantities of tires, fish plates, axles, and forgings are also made. The ingots of cast steel are made of very different weights, according to circumstances. Formerly, when they were generally hammered, they rarely exceeded thirteen or fourteen cwt.; but now that cogging is preferred to hammering, they are cast much larger, weighing up to thirty-five cwt. and measuring fifteen inches square. Each mill can cog on the average over 220 tons in twelve hours. For heating the ingots after they are taken from the Bessemer department, there are forty-six Siemens reheating furnaces, supplied with gas from seventy-two producers, which are arranged in two rows outside the building, and which are charged by a mechanical apparatus, invented by Mr. Charles Smith, brother of the manager. The heads of the hammers used for the large forgings each weigh ten tons, and the anvils 197 and 203 tons, all these having been cast at the works. The powerful high rail mills are driven by beam engines which were specially designed by Mr. J. T. Smith. Rails up to 100 feet in length and of very different sections are rolled in these mills. A hydraulic lift is attached to the roughing rolls in each mill for the purpose of raising the bloom, after passing through the grooves in the bottom rolls to those in the top. The lift consists of a table, fourteen feet by seven feet, supported by an arrangement of the shafts and levers, and actuated by an eight inch hydraulic cylinder placed underneath. Behind each rolling mill is a circular saw, which was designed and constructed at the works for the purpose of cutting off the cross-ends of the rails. The rail is carried the required distance by self-acting gear attached to the saw, which is also made to travel sufficiently far to cut the rails through. The rails pass from the saw to the straightening presses, which are at the extreme southern end of the buildings. The engines in the various parts of the works represent 9,000 horse-power, and there are altogether 150 boilers. Everything is planned and designed to work with as much as possible of automatic action, and with as little as possible of manual labor.

Such is a brief outline of the great works which Mr. Smith's practical knowledge as an ironmaster has done most to create and perfect. We have now to describe some of the services which Mr. Smith has rendered, not only to these colossal works, but to the steel trade in general. Bessemer steel rails have been made at these works since 1865, and under the direction of Mr. Smith records have been kept of their strength, resistance to wear, and other qualities. The results were communicated by Mr. Smith to the Institution of Civil Engineers in 1875, and were of the greatest practical value. He found that with ordinary care in the selection of materials and in manipulation, there is no difficulty in producing mild steel of constant quality. This long series of observations on the duration of rails of different qualities led him to the conclusion that pre-eminently the best material for their manufacture is steel with 0·3 per cent. of carbon and a tensile strength of thirty-two tons. "Such rails," he said, "are absolutely certain to withstand any shock that can be applied in punching or ordinary wear, and they will never fracture under the most severe 'tup' test at the first blow. Numerous experiments have proved that if the tensile strength does not vary beyond the given limits the remaining qualities can be predicted with exactness; but when the tensile strain exceeds thirty-four tons, no such absolute dependence can be placed on the steel." He also demonstrated by numerous experiments that the longevity of rails did not increase with their hardness; on the contrary, the softer ones showed the minimum of wear. Observing that while eight years of exceptionally heavy traffic had not deteriorated the quality of the metal, yet the force required to break the rail was considerably reduced, Mr. Smith made some additional experiments in order to ascertain the cause of this exceptional weakness. Pieces of the same rails were heated to a dull red and allowed to cool gradually, and then it was found that the breaking strain was equal to that of a new rail of the same section and properties. It was also found that when the wearing surface, both at the top and bottom of the rail, was planed off to the extent of ⅛ inch, the flexibility of the rail was restored. From these facts Mr. Smith infers that the material forming the wearing surface of the rail enters into a condition of extreme molecular tension; although the portion affected is certainly not more than ⅛ of an inch in thickness, and may not improbably be much less, yet it exerts a very considerable influence on the elasticity of the whole rail and its power of resisting a bending strain when such is applied to force outward the worn surface. Hence if a worn double-headed rail be turned, though the new wearing table will be as strong as when first made, yet it may be considered certain that the total strength of the rail is destroyed; but by planing off a thin section, the strength can be entirely restored, allowance being made for a proportionate decrease in the weight of metal.

Another permanent improvement in the manufacture of steel, which Mr. Smith was among the first in England to carry out on a large scale, was the use of molten iron direct from the furnace. When the Iron and Steel Institute met at Barrow in 1874, some discussion took place as to the possibility of running the molten iron direct from the blast furnace into the Bessemer converter without first casting the iron into pigs as it came from the furnace, and then remelting the pigs before putting the iron into the converter. It was admitted on all hands that, if this could be done, it would be a very economical improvement. It was stated that at two or three Continental works this plan was actually in operation; but there the Bessemer pits were close to the blast furnaces, and at Seraing, where, as was generally the case in England, there was a considerable distance between the two departments, new blast furnaces were being built for the express purpose of having them near the Bessemer plant in order to use the molten iron direct from them. At Barrow the iron and steel works are only 200 yards apart, but as the Furness railway runs between them, it was impossible to convey the molten iron direct from the one to the other without carrying it over a circuitous route of nearly two miles. The blast furnaces having been reconstructed in 1870-72, it was manifestly inexpedient to follow the example of Seraing. On the other hand, in their present situation they have the advantage of tipping the slag into Walney Channel, lying close behind them, and the quantity of slag thus disposed of is so enormous that a considerable area of land is annually reclaimed from the sea. In these circumstances Mr. Smith determined to try the experiment of conveying the molten metal on the line of railway, from one and a half to two miles, to the Bessemer converters. For this purpose a railway cutting was made at the foot of the pig beds in front of the blast furnaces and an incline at the end of the steel works, so that a locomotive could draw the carriage containing the ladle full of molten iron from the pig beds, run it over the detour of nearly two miles of rails, back it up to the converters, and then discharge it therein. When everything was prepared for this arrangement, it was found that the whole operation could be done in half an hour. In March, 1876, Mr. Smith informed the Iron and Steel Institute that for the preceding six months, night and day, their trains, regulated to time, had run once every hour, each time taking two ladles with seven tons of molten metal in each to the converters; and that the cost of transit was less than that involved by the old method of putting the pig iron into wagons and unloading it again for the purpose of remelting in the cupola furnace. Not only was the new method more economical, but the iron produced in the blast furnace was made better and more regular in its quality. As there was no means of testing the quality of the iron before putting it direct into the converter, more care was taken in the management of the blast furnaces so as to secure uniformity of quality, and consequently it was found, contrary to preconceived expectations, that the molten iron conveyed direct worked very much better in the converters. Contrary to expectations, too, no difficulty has been experienced by the chilling of the molten metal; a small quantity of coal dust is sprinkled over the top, and in this way it arrives at the converters without any injurious loss of temperature.

The Barrow Steel Works were also among the first to try the open hearth process. Under the superintendence of Dr. Siemens, an experimental trial of the manufacture of steel on the open hearth was made there in July, 1867, when steel of fair quality was produced; but as the furnace used was only one of the set of reheating furnaces required for carrying on ordinary work, its use as a steel-producing furnace was then discontinued. Now, however, three new furnaces of the most improved type have been constructed for the production of those descriptions of steel that are best made on the open hearth.

Last, not least, the system for the compression of steel ingots by steam has been adopted at these works. Sir Joseph Whitworth was the first who practically demonstrated the merits of compressed steel, but he used hydraulic pressure. In America, especially at the Edgar Thomson Steel Works, steam pressure has been applied with great success. The arrangements adopted at Barrow for the same purpose—the expulsion of the gases—are modifications of those in use at the Edgar Thomson Works. The fluid steel from the converters is run into a row of ingot moulds by means of a trough that runs on wheels. Each mould is provided with a steam-tight cover, which is connected by a wrought iron pipe with a main steam pipe, through which steam is supplied from a boiler that is intended to be worked at a pressure of 200 pounds per square inch. Steel compressed in this apparatus is thereby made free from the innumerable cells formed by the presence therein of hydrogen and oxygen gases, which are occluded by high pressure.

In the town which Mr. Smith's services have done so much to promote his name is a household word. When Barrow was made a borough he was a member of the first council, and he was the second who filled the mayorial chair. He was first elected as mayor in 1872, and was re-elected in the two following years. At the conclusion of this unusually long term of office he was, in 1876, publicly presented with his portrait in recognition of his services to the borough. This picture he handed over to the town, and it now hangs in the Town Hall. He is still an alderman of the borough, and a justice of the peace for Lancashire. An account of the rise and progress of the town of Barrow, published in 1873, says: "For its large works, as well as for the general prosperity of the town, Barrow is very largely indebted to the energy, ability, and business genius of Mr. J. T. Smith. From the kindliness of his disposition, from his genial manner, from the way in which he has invariably laid himself out to study the individual interests of all connected with the progress of the community, he has assuredly earned a high right to the affectionate respect of all who have ever been brought into intimate connections with him, and has at one and the same time proved himself to be a skillful man of business."

Mr. Smith has for many years been a member of the Institution of Civil Engineers and an associate of the Institution of Naval Architects. He was elected President of the Iron and Steel Institute at the Dusseldorf meeting in August last.

WATERPROOFING pasteboard may be effected with a mixture of four parts of slaked lime into three parts of skimmed milk, with a little alum added. As soon as mixed, the pasteboard is brushed over with two successive coatings of the preparation, and thus becomes impervious to water.

SWORD VS. LANCE.

AT the end of last June a military tournament was held at the Agricultural Hall, Islington, Eng., of which we present opposite an elaborate rendering by Mr. Charlton. The number of entries was 772, of whom 112 were officers, and the remainder non-commissioned officers. Regulars, militia, yeomanry, and volunteers, were alike admitted to the fray. It is noteworthy that the tilting and tent-pegging were mainly confined to those branches of the service which do not use the lance in their ordinary drill.

The opponents in Mr. Charlton's picture are placed at the ends of the lists, and at the word of command, charge, meeting about the center. The lancer has charged the swordsman, who has parried his thrust, or rather, is in the act of doing so, and if the swordsman is quick enough before the lancer wheels off or guards himself, he will have the best of the bout.

We may add, in connection with this subject, that the Belgian War Minister proposes to transform the regiments of lancers into dragoons, as the lance is found to be an impracticable weapon.—*London Graphic.*

PIKE'S PEAK A VOLCANO.

THE probability of a volcano existing in the Rocky Mountains has never entered the minds of our citizens. Conclusive evidence that such a thing does exist, and not very far from Colorado Springs, has recently been furnished us by Sergeant O'Keeffe of the Signal Service. The first knowledge that was given us of this peculiar and newly discovered phenomenon was reported last Saturday afternoon, and since that time a *Gazette* reporter, under the guidance of Sergeant O'Keeffe, visited the scene of what proved to be one of the most wondrous discoveries ever brought to light in this mountain region. Nearly all of the citizens of Colorado Springs have seen or read of the crater which is located near the summit and just west of the Peak. It has always been conceded by scientists that this self-same crater had in times gone by been the scene of a terrible eruption, as particles of lava had been discovered in the crevices of the rock adjoining it. Those who have investigated more closely the various formations which are peculiar to a volcanic mountain generally have affirmed that there are plenty of evidences to show plainly that the Pike's Peak crater has in its center a circular or cup-like opening through which lava has certainly been emitted.

It was on the night of the 29th of October that the crater first displayed any signs of volcanic activity. Sergeant O'Keeffe was aroused from his slumbers by a dreary, doleful sound which apparently emanated from beneath the signal station. His first convictions were that it was an earthquake, but this impression was soon dispelled by the fact that the sound still continued without any signs of a jar. The sergeant concluded to investigate the cause of this mysterious sound, and he and his assistant, Mr. F. L. Jones, dressed themselves and started out in search of the cause. They had barely stepped over the door-sill when a bright flash, at first thought to be lightning, surmounted the summit of the Peak. It was only of a second's duration, and the Peak was again clothed in darkness. From this time on the sound heretofore described seemed to decrease until the usual quiet of the solemn mountain peak was again restored. The following day Sergeant O'Keeffe visited the crater, feeling confident that the sound heard the night previous had emanated from that source. What was his surprise on looking down into the crater to discover vapor curling up from the cup-like inclosure. This discovery only prompted him to further continue his researches, and after two hours' laborious climbing he found himself standing within about 200 yards of the crater chimney. The heat even at this distance was very oppressive, and the ground about him was covered with pulverized ashes and lava which had been emitted from what he believed to be an incipient volcano. O'Keeffe was lost in astonishment. The snow for a distance of half a mile from the crater had entirely disappeared. This was all the more remarkable as it had upon the day previous been several feet in depth. The sergeant was very much astonished at the remarkable discovery thus brought to light, but he was not deceived by the calm. He was convinced that the absolute repose which the volcano then displayed would be of short duration. Since the 29th of October but one eruption had occurred, and that was on the night of November 7, when another one similar to that which occurred on the 29th, only more violent, occurred. Sergeant O'Keeffe happened to be upon the roof of the signal station on this occasion, and he portrays the majesty of the scene as the grandest that he has ever witnessed, not excepting that of Vesuvius seen by him in 1822, when he was a lad. The eruption began with a tremendous burst which shook Pike's Peak to its very foundation, hurling into the air dense clouds of ashes and lava. These explosions succeeded each other with rapidity and increased violence for about one hour, when the volcano seemed to enter into a profound sleep. During the eruption the clouds are strongly illuminated by the reflection of the glowing lava in the crater, giving the scene the appearance of a vast conflagration. This will account for the peculiar light which has been noticed by the sheep herders on the plains east of this city. Scientists give it as their opinion that the present upheaval will last about three months, after which the volcano will settle down to a state of comparative repose, only to burst with renewed vigor in about six years.—*Colorado Springs Gazette.*

CLIMATIC CHANGES IN ASIA.

A PAPER of unusual interest was lately read by the Rev. Owen Street before the Geographical Society, at Chickering Hall, New York, upon the evidences and the effects of the great changes which must have occurred, during or since the prehistoric and early biblical period, in the physical geography and climate of that part of Asia which is ordinarily regarded as the cradle of the human race. This region, which is now a desert, parched with torrid heat, was once well watered, had a fertile soil, and a temperate climate, and was the home of a population that ruled the world. The speaker attributed the change chiefly to the more extended water areas of the early ages. He pointed to the time when a large part of what is now central and northwestern Asia must have been submerged by a great Mediterranean Sea, of which the present Caspian Sea and Sea of Aral were only parts. As one of the evidences of this he referred to the remarkable depression of territory north of the Caspian, twenty thousand square miles in extent, to which Humboldt first called attention. Again we must take into account the fact of the existence at an early age of a comparatively mild climate in northeastern Siberia, and as a consequence the softer and milder temperature of the trade winds which blow thence southwestwardly over Asia.

Beginning as cold, dry winds, they grow more thirsty as they grow warmer, and acquire an intense desiccating power. They drink up the waters of the Caspian, the Sea of Aral, and the other salt lakes of Asia, and also of the eastern Mediterranean. They have blighted and blasted Mesopotamia and Persia, and turned what was once a paradise into an arid waste. In conclusion, the speaker argued that the climate enjoyed by the ancient Assyrians must have been an insular climate like that of the modern British, and he closed with a well-drawn parallel between the national characters of the two races.

NEW ELECTRIC MOTOR.*

By WILLIAM WOODNUTT GRISCOM.

AN electric motor, as the name indicates, is an engine for converting electricity into mechanical force. This is done most efficiently through the medium of electro-magnetism, and the honor of inaugurating the movement which has led to the utilization of this force as a motive power belongs to our own Professor Henry. His first paper on this subject appeared in 1831. In the following year Salvatore dal Negro constructed his motor and described it in detail. The first electric motors were rude machines, about as efficient as Hero's steam engine, but it hardly took the world more years to perfect the one than it required centuries to complete the other. Dal Negro's motor consisted of a fixed electro-magnet, which, by suitable interruptions of the electric current, alternately attracted and released a lever by which the mechanism was driven.

In 1835, Prof. Jacobi, of St. Petersburg, constructed an electric engine at the expense of the Czar Nicholas, with which, after four years of further experiment, he was able to drive a twelve-oared boat against the swift current of the Neva at the rate of three miles an hour. His enormous battery consisted of sixty-four cells, containing twenty square feet of platinum.

This was in all respects an apparent failure, and the philosopher was thoroughly disheartened while standing unwittingly on the threshold of a brilliant success. In the first place, he attempted the impossible in trying to get a great power economically from any battery, and in the second place no powerful battery had yet been invented. But his engine was an excellent one, and the subsequent inventors failed to equal it until Gramme, of Paris, discovered that one of his own dynamo electric generators would act in the reverse direction as an admirable motor.

The interval between 1839, when Jacobi's motor was abandoned, and 1870, when Gramme's machines came into notice, was occupied by a large number of inventors, who brought to their work a world of ingenuity, and all the learning of all the sciences save one, but that one was the only key to success—*electro-magnetic induction*. In the meanwhile Mr. Joule, himself a former seeker after this nineteenth century philosopher's stone, dashed the hopes of his co-inventors by his demonstration of the conservation of energy. This magnificent work, the grandest perhaps in the history of science, was immediately made the basis of a series of experiments, which it would be out of place to detail here. Suffice that Mr. Joule proved to the satisfaction of all scientific minds that the mechanical energy of the electrical current, produced by the consumption of one pound of zinc in a Daniell's cell, is equal to 1,106,160 pounds raised to the height of one foot; in a Grove's cell, which has one and three-quarter times the electro-motive force of Daniell's, to 1,843,600 pounds raised to the height of one foot, or, in the sulpho-chromic acid battery now before you, which has double the electro-motive force of a Daniell's, 2,212,320 pounds raised to the height of one foot. Dr. Scoresby and Mr. Joule state their conclusions in the following sentence: "Upon the whole we feel ourselves justified in fixing the maximum available duty of an electro-magnetic engine, worked by a Daniell's battery, at 80 pounds, raised one foot high for each grain of zinc consumed." This is about half the theoretical duty. In a Grove battery the same proportion would give 144 pounds, and in the sulpho-chromic battery 180 pounds, raised one foot high for each grain of zinc consumed. This result was immediately compared with the duty of the best type of steam engine per grain of coal, and it was found that one grain of coal lifted 143 pounds one foot high. But zinc, at the most favorable computation, costs ten times as much as coal, and the force it yields is, therefore, as 143 is to $\frac{180}{10}$, or about nine times as costly.

The conclusion instantly drawn by the scientific world was that electricity produced by the consumption of zinc can never compete with steam, but it is the purpose of this paper to collect certain facts which will show that this conclusion is erroneous.

History is teeming with instances where noted scientific men declared that there was nothing attainable beyond their immediate vision, and proved with sarcastic argument and brilliant syllogism that further advance in certain directions were impossible. So it was with the steamship. An eminent scholar and mathematician, some fifty years ago, proved beyond the peradventure of a doubt that an ocean steamship was an absurd dream. His calculations showed that one could not be built large enough to carry her own coal across the Atlantic. And so these gentlemen, having proved that electricity produced by zinc is nine times as costly a source of power as steam produced by coal, predict that electric motors can never usefully compete with steam engines. Now, man power, according to the tables of a well-known English engineer, is one hundred times as costly as steam; nevertheless there are several circumstances in which we prefer men. It is certain that we would never employ men if we could get a steam engine to do the work more cheaply, and it is equally certain that we would not use electricity where steam was applicable. But steam is *not* applicable, for reasons which will be given later in detail, to work in which we require a small amount of power in constant readiness for action. In these cases—such as jewelers' lathes, dental engines, and the various tools of small machine shops, which employ but a small force of men—we have never been able to find a source of power adapted to the work which, if not as cheap in proportion as large steam engines, should yet be more economical than human energy. The fact is that whereas, according to Joule, the best electric motors are nine times as costly as steam power, human energy is eleven times as costly as electricity. And, inasmuch as human energy, which is one hundred times as costly as steam, is frequently preferred to steam engines, *a fortiori* electricity will often be preferred to steam; and it will require no argument to show that the human energy thus saved from exhaustion in the exercise of brute force can be devoted to a higher use.

By way of illustration, the application of human energy to the sewing machine is not only a false economy, but has proved the cause of many new and painful diseases in female operators, which embitter their lives and affect the physique of their offspring. If any motor can be substituted for human energy in this field, there can be no greater or more convincing consideration offered to invite attention to it.

The sewing machine is in almost every house, and the seeds of these diseases are spread in every class of society. The remedy, as before mentioned, is a household motor, and it was natural to suggest a small steam engine for this purpose; but steam is unsuited to this end, because

First.—It requires time and trouble to start it to work, and a busy housekeeper, who may only need, perhaps, to do five minutes of sewing, has no time to waste.

Second.—It is always liable to explode, or to burn out the boiler, or get various portions of its complex mechanism out of order, so as to require an experienced engine driver to repair it.

Third.—It emits an offensive odor of burnt or boiling oil, and vitiates the atmosphere with the products of combustion.

Fourth.—It is really much more expensive than those steam engines from which our calculations were made. If gas is consumed for a household engine, the fuel amounts to from twelve to twenty-five feet of gas per hour, costing for a motor giving one thirty-third of a horse power, as much as the fuel of a six or twelve horse-power steam engine.

This last consideration would not weigh with the actual sufferers of the acute forms of disease, but the other objections are serious, and apply to all heat motors, such as gas, steam, and caloric engines.

Other motors are before the public—the various hydraulic motors which require the special introduction of water-pipe and waste pipe, and entail yearly visits from those friends of humanity, the plumber and the tax collector. Then there is the spring motor, which you wind up every quarter of an hour or so, expending, of course, much more power in the winding than you get out of it in work, and which has an unhappy habit of bursting its bonds occasionally and venting its store of energy where it is least needed. Then there is the curious chair motor, whose mechanism is connected with the seat of the chair, and by various levers, cogs, cams, and clutch to the sewing machine. The seat of the chair gradually sinks about three inches beneath the weight of the operator, driving the sewing machine the meanwhile. The operator then rises, the spring lifts the seat, and the performance is renewed. A rapid speed can be attained by rising and sinking forty times per minute.

It is now fair to examine the theoretical and practical objections to electric motors, used with batteries. They may be divided into two classes—those which utilize the attraction only of an armature to an electro-magnet like the motor which drives the clock in the Institute library upstairs, and those which utilize the attraction and repulsion of two or more electro-magnets.

The former act by intermittent attraction only, and are wasteful of electric energy, because the residual magnetism, during the interruption of the current, retards the passage of the armature away from the pole which has just attracted it.

Those of the latter type, however, convert a portion of the retarding influence of the residual magnetism into a useful force. In fact, all dynamo-electric generators, when used as motors, convert all magnetic resistance to motion into a counter electro-motive force. At first glance it seems strange to consider a counter force as an economy, but in point of fact it retards the consumption of zinc in the battery and tends to depolarize the negative plate. It has been usual to regard this counter electro-motive force as increased resistance, but a simple experiment will show the error of this view, and will at the same time demonstrate that economical motors must also be efficient dynamo-electric machines in order to recover this force, which would otherwise be lost. A small motor of the type before you was held motionless while a sufficiently powerful current—let us say of four webers per second—traversed its coils. A tangent galvanometer was in circuit, whose deflection was carefully observed. Then, without changing the connections, the motor was allowed to run at full speed, when the galvanometer indicated about one-fourth of the original amount of current. The electro-motive force of the battery was practically constant, and, therefore, according to the formula

$$\frac{\text{Electro-motive force}}{\text{Resistance}} = \text{Current}$$

the galvanometer should have indicated the same current as at first, unless the resistance has been changed or a counter electro-motive force produced. The speed of rotation was then diminished by a brake, and the needle immediately indicated a greater current. This is in direct conformity with the well-known law that the electro-motive force of a dynamo-electric machine varies with the speed of rotation, whereas the resistance of a coil is not affected by mere motion.

A still more striking proof that the "back-pull" of residual magnetism may be converted usefully into electricity is exemplified in a motor constructed more than a year ago by the writer on the same principle as this one, save that the field coils are free and not connected with the battery. The current of the battery is sent through the armature, which revolves with considerable rapidity. If the free ends of the field coils are now connected the speed is immensely increased, and if the ends are separated a spark appears. Of course there is some loss. The entire amount of energy wasted in retarding the armature is not recovered, but nevertheless the increase of power due to this one economy is very astonishing.

The little motor exhibited this evening is also an efficient dynamo-electric machine. The most essential advantage which it possesses over the older forms is in the field magnets. Their peculiar shape is such that all the magnetic lines of force, including those nearest the neutral line, are brought into the best possible position for effecting the revolution of the magnetic armature. I believe that the distinguished inventor, Mr. Ladd, of England, claims, in an article which appeared lately in one of the journals, to have discovered the great advantage possessed by the lines of force of a nearly circular magnet over those in the usual horse-shoe form magnet, but he does not appear to have attempted to utilize the lines of force which fill the interior of a curved magnet from the neutral to the polar points. If a bar of soft iron is pivoted at one end, so as to move in a horizontal plane, and a semicircular magnet is placed concentrically with the circle which the bar can describe, it is found that a given force is exerted upon the bar, at a much greater distance from the poles, when the latter is within the semicircle than when it is without. I believe that no field magnets of this principle have ever before been made, and herein is the secret of the power of this little motor, which weighs about 2¼ pounds, and which compares favorably with those of the old forms of fifteen times its weight. The inductive actions which are produced in these field magnets at each revolution of the armature are exceedingly complex, and I shall not trespass further on your attention, except to give a brief resume of the practical defects of electric motors, and how they have been overcome, in the investigation of which this motor is the result.

The great bugbear of those who have used electric motors has been the battery. It gave forth offensive and poisonous vapors; it required almost continual attention; it used concentrated acids, and it became rapidly exhausted whether it was used or not. It was the frequent cause of accidents to clothing, its cells were readily broken and the connections were constantly eaten away.

All these objections are now done away with. The present battery is inclosed in a strong water-proof box, does not use concentrated acids, gives out no odor, does not exhaust itself, requires renewing only after the fluid is used up by actual work, will last months or years if left to itself and be in good order as at the beginning. It requires absolutely no attention until the reservoir is exhausted by actual work, and it is ready without a moment's warning at all times and seasons. It is calculated that the battery will suffice for the sewing of a small family for one year. A professional seamstress would exhaust it more rapidly, but always in proportion to the exact amount of work done. It will be shown that this form of battery places the speed of the motor under complete control without effort on the part of the operator.

The attention of mechanicians is invited to the fact that this form of motor, owing to the force being applied equally to both sides of the shaft at once, entails absolutely no wear on the journals except from the weight of the armature, which is very light, and the tension of the belt, which transmits the power. The length of bearing is four times the diameter of the shaft, and the design of the motor is such that no amount of wear can cause the poles of the armature and magnets to come in contact, which was a frequent source of annoyance in other motors. The motor is attached to the machine, and is of such dimensions as to be readily concealed from view if preferred. There is also a device for readily changing the tension of the belt.

The power of the motor is sufficient to sew leather, or as much tightly woven linen as can be put under the presser. With a sufficient battery power it can give any speed varying from twenty to two thousand stitches per minute in instant obedience to the will of the operator. A safe working speed for constant use is eight hundred to one thousand stitches per minute, which is considerably faster than is now attained by professional sewing women, while others seldom sew more than three hundred to four hundred stitches per minute.

[The principles embodied in the paper were illustrated by a small model weighing 2¼ pounds attached to a sewing machine and a battery of six cells, each containing one plate of zinc four inches long and two inches wide. The machine did both light and heavy work, and the speed was under complete control. The battery was sensibly constant, showing no signs of polarization. The current was estimated at two webers per second, and the force generated at 1,000 ft. lbs.]—*Journal Franklin Institute.*

* Paper read before the Franklin Institute, Nov. 17, 1880.

AN ESSAY ON THE NATURAL ENEMIES OF THE TELEPHONE.

By T. D. LOCKWOOD.

AT the request of several persons actively engaged in the business of telephony, I have taken up this subject, though comparatively unprepared to give it consideration commensurate with its vital importance to every one who uses a telephone in any form or manner.

When some future historian of the world engages in the ever-increasing task of recording the vicissitudes, changes, and progress of this self-sufficient planet, and, after reviewing the dark ages of antiquity, the classic age of Grecian domination, the iron age of the Roman republic, the Augustan age of the empire, and the semi-barbarism of the middle ages, arrives at the present era, he will have no difficulty in deciding that the proper designation wherewith to immortalize it will be the "electric age."

For we employ the unseen, yet active, all-powerful, and universal force, or agency, in almost every service that can be imagined.

If the school-girl's definition of electricity, namely, "a force known only by its manifestations," be correct, as with some modifications it undoubtedly is, it must still be conceded that its manifestations are illimitable, and that the human race has accomplished great results in subduing so thoroughly what was, even until the present century, so untamable, wild, and free.

We send our thoughts over land and sea; we speak to distant friends and correspondents without leaving the fireside; we light our gas instantaneously, without regard to the number of burners; we leave our banks and counting houses secure; watch our watchman; spread our fire alarms; explode our mines; regulate our clocks; light our streets and halls; keep one day ahead of the weather, and ring our domestic bells by the aid of the wonderful and mysterious force; and yet we do not know what it is!

Those who know it best regard it as a form of energy which causes the infinitesimal particles of matter to alter their positions in regard to one another.

The telephone, though not discovered until 1876, is based upon one of the best-known properties of electro-magnetism, namely, the fact that "when a spool of wire with a soft iron core is fixed on the pole of a permanent magnet, any alteration in the distance of an armature placed in front alters the magnetism of the core and sets up a current in the coil wound on the bobbin."

It is scarcely necessary at the present time to give a detailed description of the construction of the telephone, seeing that it has become, so to speak, a household word among the American people.

Suffice it to say, in explanation of its action, that the diaphragm of the telephone, when put in motion by the voice, vibrates, approaching and receding from the core, and, thereby, under the law quoted above, sets up currents in the wire of the spool, and consequently in the line wire to which it is connected; these currents pass along the line wire, and arriving at and passing through the coil of the distant telephone, act on its diaphragm, and set up vibrations exactly corresponding to those of the initial diaphragm, and thus reproduce the original sounds.

The currents caused by the very small movements of the diaphragm in front of the magnet are necessarily extremely feeble; so much so that the late Professor Peirce, of Boston,

compared them to those which would be produced by an electric source of which the electromotive force should be one two-hundred-thousandth part of the power of a Daniell cell. It is, therefore, evident that the apparatus which can be distinctly acted upon by such currents must be correspondingly delicate and sensitive.

We see, then, that the very sensibility on which the legitimate action of the telephone is so dependent becomes, under certain circumstances, positively detrimental, because it is thereby rendered equally subject to be influenced by very slight external or foreign currents; in fact by any extraneous causes which affect the electrical current of the wire.

As an inevitable result of this extreme sensibility to external currents, which are usually stronger than the delicate magneto-telephonic currents, the latter are, to a certain extent, overpowered by the former, whether acquired from the earth, or by leakage or induction from other electrical conductors; and the manifestations of the foreign currents in the receiving instrument of the telephone wire are similar to those exhibited on their legitimate apparatus, while the vocal transmission is correspondingly weakened. We will now consider and endeavor to classify the different disturbing sounds heard in the telephone, and then trace them to their several originating influences.

These may be arranged in five classes:

First: Frying, hissing, and bubbling noises.

Secondly: Screaming and whistling noises.

Thirdly: Jerking and rasping noises.

Fourthly: Morse or other telegraphic communication in course of transmission on other wires.

Fifthly: Telephonic conversation, or vocal sounds in process of transmission on other wires.

Of course, the telephonic lines are also subject to interruption from other causes, such as breakage of wires, circuits accidentally left open, crosses, or contacts with other wires, and escapes, or grounds; but these troubles, being comparatively well understood, do not come within the scope of the present article.

The noises and disturbances of the first and second classes are, I conceive, almost totally due to earth currents, atmospheric electricity and thermo and hydro-electric reactions.

Earth currents are now known to be always traversing the wires. They affect lines running northeast and southwest most frequently, and vary with the time of day.

There is, likewise, always free electricity in the air and in the clouds, which acts on the earth and on the wires, they being generally conductors to earth.

These noises are much more intense by night than by day, on long lines reaching their maximum about 12 midnight, the disturbances of the second class becoming especially intolerable in the night.

M. Gressier, a French philosopher, accounts for these disturbances as follows:

During the day the current developed between the wires and earth plates, on the one hand, and the earth itself on the other, the poles being the conducting medium between the two, are directed from the line to the earth, because the heat of the wire is greater than that of the earth, the currents being then thermo-electric.

During the night the wire becomes cooled, while the earth retains its heat; the currents then flow from earth-plate to line, and are hydro-electric. No line in which the earth forms a part of the circuit can be totally free from these disturbing influences; consequently, the only radical remedy for them is the use of a metallic circuit. This being very expensive and inconvenient, it is well that disturbances due to the foregoing causes are not so violent as to interpose serious difficulties in the working of the lines, with the exception of very long ones, when the battery transmitter is employed.

We now proceed to the third class of interfering sounds—jerking and rasping noises.

These I regard as being chiefly attributable to defective joints in the line wires and loose connections in instruments. Such imperfect contacts set up true microphonic action, with its resultant sounds. The remedy for this class is obvious: More care in making and soldering joints, and more attention to the inspection of instruments and lines.

We now come to the disturbances which constitute the worst enemy of the telephone electrician, namely those which I have arranged in classes 4 and 5.

These are undoubtedly due to a variety of causes, the principal of which are leakage of currents from other wires; electro-dynamic induction and static and magnetic induction; those of the fifth class being also referable to the surcharging of insufficient and inefficient ground wires in central offices.

The first cause, leakage, is not exclusively an attendant on telephone lines; being likewise an old bugbear of all telegraph lines. Imperfect insulation allows the current to divide itself between all the wires on the pole, in proportion to their respective resistances; and as the shorter the wire the less the resistance, the tendency is to escape from a long circuit into a short one. When the current escapes to the earth, no great harm is done, as the only effect is to weaken the signals; but when it leaks into another wire, it confuses the signals on the second line. It is obvious, therefore, that the true remedy for this trouble is to convey the escaping currents to earth.

The plan recommended by Mr. Varley, many years since, and adopted on the English lines, is to attach a thick wire to the pole, coiling the earth end in a spiral under the foot of the pole, and letting the upper end of the wire project above the top of the pole to serve as a lightning conductor. Wires are then attached to the under side of the cross-arms, and one end fastened firmly to the insulator pins, while the other end is firmly spliced and soldered to the thick wire running down the pole. The leaking currents thus find it easier to go to earth than to any other wire. As no insulation is absolutely perfect, this arrangement should be applied to all long lines. It is, of course, most effective when the earth wire is attached to every pole. The earth wires, however, do more harm than good when they do not make a good earth connection; and it may here be stated that a buried plate to which the pole wire is soldered is the best earth. In some places the earth wires have been merely coiled a few times around the butt of the pole. Such a contrived earth has, on its resistance being measured, been found to vary from 2,100 to 6,000 ohms. It cannot, therefore, be commended. If good earth cannot be obtained in some places, an uninsulated wire may be run from pole to pole, connected to the earth wires on the cross-arms, and put to earth at convenient points.

This subject is fully canvassed in Culley's "Handbook," and Preece's "Telegraphy." The arrangement, though well known in England for many years, was patented by Mr. Varley in this country in 1868, and in a recent patent has been improved by the application of metallic sleeves, or sockets, in the cross-arms, to which the lateral earth-wires are attached, and in which the insulator pins are inserted; also by running the uninsulated wire attached to all the ground wires throughout the whole length of the line. When well applied, the earth wires carry off a large percentage of the interfering currents.

Electro-dynamic induction is the next cause, and, after leakage, is the most troublesome. It is very difficult to render in a clear manner, to persons unacquainted with electrical phenomena, the idea expressed by the word induction. The majority of those actively engaged in the telephone business, it is well known, are not practical electricians, and for this reason the word induction, spoken and written of a few times in reference to telephonic disturbances, has been eagerly snapped up and applied indiscriminately to all kinds of such disturbances. It is, however, a well-defined term; has a well-defined meaning, and well defined laws. It was thoroughly studied by Faraday, who made public his experiments with their results. Induction, briefly expressed, is the name given to electrical or magnetic effects produced in bodies to which the exciting cause is not directly applied.

Dynamic induction is the power which a current in motion has, when flowing in a conductor, of inducing currents in neighboring conductors. The most obvious remedy for troubles originating from this cause is the employment of a return wire, parallel and near to the first, instead of an earth return. Under such conditions, the currents induced on one wire would be neutralized by those resulting from the same induction on the second wire, which would then act in an opposite direction. This, however, would only be efficient when the wires were near each other, and both equally near to the disturbing wire. This idea was early proposed by several persons.

Another idea was broached by Mr. Preece, in a lecture before the Royal Society in 1877, which I am disposed to regard as effective.

It applies both to static and dynamic induction. Static induction, it may here be well to explain, is that influence which an electrified body has on all conducting bodies in its immediate vicinity.

Mr. Preece's proposed remedy was to interpose between the telephone wire and the other wires a conducting body in communication with the earth, and capable of acting as a screen to the induction, by itself absorbing the electro-static effects.

He suggests a practical application, in the employment of insulated wires covered with an iron or metallic case, the case being in direct communication with the earth. It is my impression that the outside conductor, even if unconnected with the earth, would very much counteract the dynamic induction, by setting up a counter induced current to that of the inducing wire, and also by absorbing into its greater substance the currents which would otherwise be divided among the other wires on the same poles. The earth connections, I think, effectually dispose of the static induction, on the principle quoted by Jenkin, in his valuable work on electricity, in which he states, as a well-known fact, that if an uninsulated metal plate be interposed between an electrified body and an insulated body, all inductive effects cease, but if the metallic plate be insulated it has no such effect.

To the best of my knowledge, this remedy, of insulating the conductors and then surrounding them with a conducting medium in connection with the earth, has never been applied to pole lines, chiefly on account of the expense. It has, however, been applied to conductors, when grouped together into a cable, and gives satisfactory results.

First recommended, so far as the telephonic application is concerned, by Preece, it was, in 1877, tried on the post office telegraph lines in England. Subsequently it was applied to telephone lines by C. E. Chinnock, of New York, an American inventor. It was then discovered that a French physician had laid down the principle, applied it to telegraph cables in 1869, and patented the cable.

This cable is made substantially on the plan spoken of by Preece, and works well. Subsequent experiments lead to the belief that if conductors are grouped together, well insulated, and the whole inclosed in a metallic tube, inductional troubles will be practically obliterated. In any case, the greater the number of wires the less the disturbance, as the foreign currents must divide in direct proportion to the number of wires, other things being equal.

A paragraph has recently gone the rounds of the newspapers, to the effect that a firm of Swiss wire manufacturers have discovered a new process and material for the manufacture of cables which totally prevent inductional effects. No details, however, are yet given.

Magnetic induction between wires conveying currents, though present, does not, I am convinced, interfere to an appreciable extent with telephonic transmission. It may, therefore, be ignored in the present article.

As regards the size of line wire, it is rather unfortunate that two obnoxious forces, leakage and induction, are at swords' points, leakage being lessened by the use of larger conductors, and induction correspondingly increased, and consequently diminished by the use of smaller ones. No remedy for this is at present discernible.

Lastly, I am firmly persuaded that much of the interference between wires centering in the same office, arises from the fact that far too many wires are worked from the same earth terminal, and *that* often none too reliable. I am in favor of multiplying ground wires at central offices, of using larger ground wires, and of insisting on more care in their attachments. Too much stress cannot be laid on this point.

The problem of long line telephony is rapidly yielding to the energy and thought that have been applied to it, and will, no doubt, soon be solved. When it is done, we shall probably be surprised to see how easily it was accomplished. To my mind, the chief obstacle is *poor insulation;* and I conclude by saying: Take more care to use good ground wires, use proper earth wires and their connections on poles, and, above all, *improve insulation* in every possible way.—*Operator.*

COMBINED INDUCTION MACHINE.

THE difficulty of exciting electricity in damp weather, or in rooms where many men are collected, has induced Robert Voss, of Berlin, to combine the Holtz and Topler machines. He retains the usual Holtz form. Instead of the four fixed half disks he uses one whole disk, which has about the same amount of paper covering as the Holtz. Upon this disk there are four tinfoil coverings, which are connected by couples with one another, and also with two brass pieces which are attached to the fixed disk. The pieces of brass upon the circumference of the disk serve as bearers for the gum stirrup in which the metallic brushes are fastened. The revolving disk has six tinfoil coverings, with an equal number of brass springs; the metal brushes press upon these springs. The double conductor of the machine has also two metal brushes rubbing upon the same springs. The free electricity of the air collects upon the tinfoil. In consequence of the turning of the rotating disk, and the contact of the metallic brushes with the brass spring, their electricity is increased and conducted to the paper covering of the fixed disk.—*Dingler's Journal.*

SPIRAL POLARIZATION.

A BEAUTIFUL illustration of the laws of polarization of light has lately been made by M. G. Govi. Let a parallel beam of light be passed through a polarizer, then through a thin slice of quartz cut perpendicularly to the optic axis, then through an analyzing Nicol prism. It is seen, as is well known, to be colored. This colored light when passed into a spectroscope gives a spectrum marked by one or more dark bands, corresponding to the particular rays whose relative retardations in passing through the crystal slice have produced interference. These bands are not always in one place; they are displaced right or left (according to whether the crystal is a right-handed or a left-handed specimen) if either the analyzer or the polarizer be rotated. A slice of quartz about 4·3 millims. thick produces a single band. One of 8·6 millims. produces two bands at once in the visible spectrum, the number of bands being proportional to the thickness of the crystal.

Now suppose a mechanical contrivance by which both the analyzer and the spectrum can be rotated at the same velocity. A direct vision prism attached to the front of the Nicol prism realizes the optical portion of this combination. There will be seen on rotation a circular spectrum, having either red or violet at the center and either violet or red at its outer circumference. Now since the dark band spoken of is displayed by a quantity proportional to the amount of rotation, interference will take place in this circular spectrum along points which form geometrically a spiral of Archimedes. The persistence of impressions on the retina will enable this dark spiral to be seen in its entirety, provided the rotation be sufficiently rapid. If a thicker piece of quartz be used, giving two, three, or four dark bands, the rotation spectrum will present a most beautiful appearance, being crossed by a two-branched, or three-branched, or four-branched spiral, the separate lines of which proceed from the center to the circumference. The sense of these dark spirals will change with the sense of the impressed rotation. The effects, says *Nature*, are very striking.

ON THE LIMIT OF PLANETARY STABILITY

By Prof. DANIEL KIRKWOOD.

LAPLACE, in his "Système du Monde," pointed out the limit at which, according to his estimate, the moon's attraction could have retained an elastic atmosphere.* The question of a satellite's stability was also considered by the late Professor Vaughan, of Cincinnati.† I have seen no attempt, however, to obtain for the different members of our system any definite numerical results. In the present paper it is proposed to find the approximate limits of stability in the cases of the eight major planets and certain of the satellites, on the hypothesis that their primitive condition was either liquid or gaseous.

Let M = the mass of the larger or central body;
m = that of the dependent planet or satellite;
x = the distance from the center of the former to the limit of stability of the latter;
a = the distance between their centers; then, since the disturbing or separating force of the larger upon the smaller mass is the difference between the attraction of the former on the nearest point of the surface of the latter and that on its center of gravity, we have

$$\frac{M}{x^2} - \frac{M}{a^2} = \frac{m}{(a-x)^2}, \qquad (1)‡$$

or, putting $a = 1$ and reducing,

$$x^4 - 2x^3 + \frac{m}{M}x^2 + 2x = 1. \qquad (2)$$

If we adopt the masses and distances given in Newcomb's Popular Astronomy and solve equation 2 for each of the eight principal planets we shall obtain the distance from the center of each to its limit of stability, as given in the second column of the following table. If, moreover, the planets, with there present masses, be reduced to the sun's mean density, their radii as stated in the third column are found by the formula—

$$r_n = 430{,}000\left(\frac{m_n}{M}\right)^{\frac{1}{3}}$$

and the respective ratios of the limits of stability to these radii are seen in column fourth.

TABLE.

Planet.	R_n in ms.	r_n in ms.	$\frac{R_n}{r_n}$
Mercury	165,165	2,514·6	65·7
Venus	701,746	5,719·2	122·7
Earth	1,059,386	6,242·7	169·7
Mars	764,900	2,951·1	259·2
Jupiter	37,854,287	42,335	882·35
Saturn	45,859,381	28,317	1619·48
Uranus	49,512,900	15,209	3255·51
Neptune	81,663,510	16,0·9	5101·10

On the assumption that in each case the mean density of the separated mass was equal to that of the central body, the sun's present radius multiplied by the respective numbers in column fourth will give the radii of the solar nebula when the planets extended to their respective limits of stability. These radii are less than the mean distances of the planets in the ratio of 1 to 1·265. This fact may have some significance in regard to the former oblateness of the solar nebula or the law of its density.

The Earth and the Moon.—For the moon, which in perigee approaches within 221,500 miles of the earth, the limit of stability is about 38,000 miles. Were the moon's density reduced to that of the earth its radius would be 916 miles, the ratio of which to the limit of stability is 1 : 41·6. The moon's least distance diminished by 38,000 miles is 183,500 miles. If our satellite originally extended to the limit, and if the moon and the earth had the same form and density, the radius of the latter was 165,000 miles.

The Martian System.—The diameter of Phobos, according to Prof. Pickering, is 5·57 miles. If its density, there-

* "Syst. du Monde," B. IV., Ch. X.

† *Pop. Sci. Monthly* for Sept., 1878. See also the Proc. of the A. A. A. S. for 1856.

‡ We neglect the centrifugal force due to the planet's rotation, as the modification would be slight, and we propose to obtain merely approximate results.

fore, be equal to that of Mars, the limit of stability is about two miles exterior to the surface; or, if the density be to that of the primary in the same ratio as the density of the moon to that of the earth, the limit is less than a mile from the surface of the satellite; and, finally, if the density were no greater than that of water, the satellite, if fluid, would be unstable, the limit being actually within the surface. Since, therefore, the satellite could never have existed at its present distance in a nebular state, it must follow, if any form of the nebular hypothesis is to be accepted, that its original distance was much greater than the present. Can we find a probable cause for this ancient disturbance?

If we suppose the former period of Mars to have been very nearly one-sixth that of Jupiter, the close commensurability would render the orbit of Mars more and more eccentric. The planet in perihelion would thus pass through the sun's atmosphere, or rather through the outermost equatorial zone of the solar nebula. This resisting medium would not only accelerate the motion of Mars, but also in a much greater degree that of his extremely small satellite. The solar mass contracting more rapidly than the orbit of Mars, would finally leave the latter moving in an eccentric path without sensible resistance.

Other Secondary Systems.—For the first satellite of Jupiter the limit is 5,250 miles, or 4½ times the radius of the satellite. For Mimas, the innermost satellite of Saturn, it is less than twice the radius. The rings of Saturn, in all probability, could not exist as three satellites, the limits of stability being interior to the surface.*

The effect of perturbation in the dismemberment of comets is known to all astronomers. The nucleus of the great comet of 1880, which approached within less than 100,000 miles of the sun's surface, must have had a density greater than that of granite, as well as a strong cohesive force between its parts, in order to withstand the tendency to disintegration during its perihelion passage. Had the nucleus been either liquid or gaseous, or even a cluster of solid meteorites, the difference between the sun's attraction on the central and the superficial parts would have pulled the comet asunder, spreading out the fragments into somewhat different orbits, like the meteoric streams of August and November.

PANDERMITE: A NEW BORACIC MINERAL.

By C. G. WARNFORD LOCK.

BORAX (bi-borate of soda), is one of the most useful and valuable natural salts, and a sufficient supply of it is essential to the existence of an important manufacture—pottery, besides being eminently adapted to many other uses. The production of borax has long been inadequate to the demand, and has favored the utilization of native boracic acid, and borates of lime, of magnesia, and of lime and soda. Our markets are at present supplied from distant and diverse sources. Borax comes principally from Tibet and other trans-Himalayan territories, on the one hand, and from California on the other; with very small occasional contributions from Peru and Chili. Boracic acid is commercially produced only in Tuscany, and is consumed chiefly in Continental Europe. Borates of lime and of magnesia have not hitherto been shipped in any quantity to this country. All these products I have described at length in the article "Borax," in "Spons' Encyclopedia." I have now to deal with a new commercial borate, which, on the score of geographical position, abundance, cheapness of working, and easy manipulation, is certainly destined in a great measure to rule the markets of Europe, and particularly of Great Britain. The new field lies on the Tchinar-sou, a small stream feeding the Rhyndacus River, whose outlet is in the Sea of Marmora, near the port of Panderma, on the Asiatic shore. It embraces the villages of Sultan-Tchair, Yildiz, and Omerli, and the guard-house of the Demircapon pass. The area of the field is computed at over 13,300 acres (twenty square miles). Its eastern confine nearly abuts upon the Rhyndacus, which has been navigated by steamers up to a point called Balakeser. A company has been formed for deepening and improving the stream, and a railway has been projected from Panderma to Balakeser. The wagon-road has hitherto been utilized for transporting the mineral, the distance from Panderma to the western edge of the field being about forty English miles. The port of Panderma is regularly frequented by local steamers, and offers every convenience for shipping.

The field is situated in a basin of Tertiary age, surrounded by volcanic rocks, which vary from granite on the east to trachyte on the north, and columnar basalt on the west; several basaltic hills and dikes protrude in different portions of the basin, and the presence of hot and mineral springs further testifies to the volcanic influences which have been at work, and in which, doubtless, originated the boracic mineral. The latter occurs in a stratum at the bottom of an enormous bed of gypsum, its greater specific gravity probably impelling it downward while the whole mass was yet in a soft state. Several feet of clay cover the gypsum bed, which is here sixty to seventy feet thick, though in places it attains to double that thickness. The boraciferous stratum varies in depth; it has been proved for a vertical distance of forty-five feet. The mineral exists in closely packed nodules, of very irregular size and shape, and of all weights up to a ton. Von Rath has named it Pandermite, from the port of shipment. In outward appearance it closely resembles a snow-white, fine-grained marble. Chemically speaking, it is a hydrous borate of lime, its composition being expressed by the formula $2CaO,3B_2O_3,3H_2O$: in other words, it consists of boracic acid, 50·85 per cent.; lime, 29·78 per cent.; and water, 14·36 per cent. Its richness in boracic acid is at once apparent, and places it high above other commercial borates. Thus ordinary borax (borate of soda), contains only 36·58 per cent. of the acid; boro-calcite and boro-natro-calcite (borates of lime, and of lime and soda), vary from 8½ per cent up to 46 per cent., and average about 40 per cent. Boracite and stassfurtite (borates of magnesia), containing respectively about 63 per cent. and 69¼ per cent., alone surpass it in this respect, and they can hardly be deemed commercial minerals. After very simple preparations, pandermite can be directly applied as a flux, and is more economical than borax for this purpose, thanks to its larger proportion of boracic acid.

An outcrop of the mineral was discovered by a foreigner some years since, and the bed was secretly worked; small shipments were occasionally made to Europe, under the denomination of plaster of Paris, thus keeping the matter hidden, and at the same time avoiding the payment of dues and duties. The Ottoman Government has since been apprised of these irregularities, and has taken energetic measures to correct them. More recently, it has granted a comprehensive concession to a party of British residents, who are setting to work to develop the property. The district enjoys the great advantage of being under British protection. The workings were at first placed under that section of the *Réglement des Mines* relating to quarries, but have since been transferred to the section regulating mines proper. Steps are being taken to open up the deposit in a systematic manner, by first sinking a number of bore holes—as has been done with the kainit beds at Stassfurt—to ascertain the points of greatest development in the basin. The locality possesses a healthy climate except in the autumn, when there is some ague. Labor is very cheap and abundant, Turks, Circassians, Tartars, Armenians, Greeks, and Italians being obtainable from the neighboring villages. There is a supply of water; oak and fir timber may be procured at six to seven miles distant; and scrub for fuel covers the surrounding hills.

The actual cost of the mineral, as now worked, is as follows:

	Paràs per oke.
Raising and dressing (exclusive of cost of tools)	10
Transport to Panderma	9
Customs duty, 1 per cent. *ad valorem*	¼
Management and other charges	2¾
	22

	Per ton. £	s.	d.
At 795½ okes per ton, and 128½ piastres per £ sterling (1 piastre=40 parâs), this will equal	3	8	3
To this must be added government royalty, 5 per cent. *ad valorem*, say	0	5	0
Contingencies	0	10	0
Freight and insurance	0	15	0
Making the total cost, "*c*, *f*, and *i*"	£4	18	3

The present values of the boracic products now in the market vary from £46 to £60 per ton, according to quality; the lowest figure ever reached has been about £20 a ton, at which price the demand would immensely increase.—*Jour. Soc. of Arts.*

THE NATURAL HISTORY OF THE JEWS.

Editors Scientific American:

IT is an observation which may be made frequently that science nowadays does not always conform to ethics. Prejudices of race, caste, religion, and nationality men are in a dangerous habit of sustaining by would-be scientific arguments. The fact is that there is nothing so mean and nothing so ridiculous in this direction as not to have served as an argument to prop up some miserable prejudice originating in passions not in the least high and pure.

There is, at this time, an obvious tendency to enlighten Germany, as well as Europe, and even the world at large, in regard to the peculiar properties and special characteristics of the Hebrew race. This is, of course, due to nothing else than the recommendable desire of imparting instructive information to an inquisitive people (viz., the German) which has as yet failed to observe and comprehend the peculiar danger arising from its too implicit trustfulness and inconsiderate liberality to this race. And as, in times not long by-gone, we were used to read very long and very learned essays and papers on the absolute imperfectibility of the African, so now we may read in German publications very scientific and very profound treatises "on the natural history of the Jews." Thus the director of the Anatomical Museum at St. Petersburg, a German gentleman, bearing the familiar name of Schultze,* has discovered and accumulated an overwhelming array of facts which go to prove that the Jews (that is, the few dead Russian and Polish Jews whose bones had the honor of being thus investigated by the doctor) have "short extremities," "long trunks," "sharp noses," "lean bodies," "x-shaped legs," etc., etc.

He furthermore assures us that the Jews are cowards—more passive than active, as he adds in the way of a modifying explanation—a state of things which would not be surprising in a race that has been hunted down most cruelly and outraged most shamefully in all "civilized" countries for eighteen centuries, and is thus treated in Asia, Eastern Europe, and anew in Germany at the present day. It should be remembered that in the last-mentioned country there are hundreds, if not thousands of Jews, who have bravely fought for their ungrateful "fatherland" on many battle fields, many of whom are decorated with the "Iron Cross" for their courage and bravery.

Dr. Schultze goes on with his peculiarly scientific description, and ventures the statement that, as a counterbalance to their great mental activity and ability, "they have never been productive, either in *cultivation of the soil*—which they have not been allowed to cultivate until very recently; "or in *trades*"—which they were, until lately, strictly forbidden to learn and to follow; "or in *science* and *art*."

The last portion of this promiscuous statement is so intentionally deceptive as to be almost beyond contempt. Aside from the many living authors and artists, lawyers, and physicians, eminent men in general, we shall only mention Spinoza and Moses Mendelssohn, the philosophers, and Felix Mendelssohn and Meyerbeer, the composers. The reason for all their shortcomings in this respect is the same: They have until very lately lacked only the full liberty and freedom from the adverse influence of race prejudice, to give us their due proportion of great teachers of humanity.

Professor Karl Vogt, of Geneva, the eminent naturalist, has cleverly illustrated the prejudices now taking such ugly practical expression in Germany, the land inhabited by a "people of thinkers." He remarks:

"It is said:

"'*Jews cheat!*' Well, if they do, why are you stupid enough to let yourselves be cheated?

"Further:

"'*The Jews have absolute control of the public press!*' May be, it is so; but why have you been foolish and simple-minded enough to let it pass into their hands?

"Again:

"'Jews reign supreme in commerce, on exchange, and in money-matters generally!' Very probably this is exactly as you say; but how could such a small minority do that, if they were not men of superior intelligence, quick-eyed and sharp, and if they did not work with enormous energy and assiduity?

"And again:

"'*The Jews control more offices, count among their ranks more members of the professions (lawyers, physicians, artists, journalists, etc.), than they should in proportion to their number!*' No doubt, that is so; but, considering how much they are disliked by some governments, is this not the best conclusive proof that they are more capable, or, at least, know how to employ their abilities to better advantages, than others?

"And lastly:

"'*The wealth of the people will pass into their hands exclusively in a short time!*'

"Very likely it will. For they are temperate and saving; they work and transact business with unremitting diligence, day and night; they are very fond of their families, and, as a rule, lead a happy, domestic life. Why should they therefore not grow and prosper?

"*Go and do likewise!*"

The great *savant* concludes by declaring that the agitation in Germany is nothing but a manifestation of rage, emanating from those who are on a lower level intellectually than the race attacked—because they are civilized for many generations less than their victims.

It is doubtful whether the latter argument is fully justified, but that the former is true is best proved by the fact that all the enlightened men prominent in sciences and arts, in politics, and in the professions generally, have strongly denounced the persecution of the Jews in Germany in unequivocal terms. It may be safely said that only the plebs, high and low, stupid and malevolent, promotes this most shameful agitation.

The great material distress, which is gradually becoming chronic, is at the bottom of this almost inconceivable phenomenon. The causes of this distress and poverty are not allowed to be discussed publicly as they deserve, and therefore an imagined cause is found in the prominence and wealth of a majority of Jews. Religious differences which, although not valid, would still be plausible reasons, are not at all concerned, just as little as logical arguments. Let us hope, therefore, that *science* refuses in this, and in all similar controversies may henceforth refuse, to be the handmaid of envy and prejudice, and that deceptive statements and reports, such as those made by Dr. Schultze, are no longer thought worthy of serious attention and consideration.

G. W. R.

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—The Egyptian Obelisk in America. 7 figures.—Showing the progress of the obelisk from Alexandria to Central Park ... 4061
Hodson's Rotary Engine. 1 figure ... 4059
Improved Rotary Valve Gear. 4 figures ... 4059
Improved Lubricator. 1 figure ... 4059
Proposed New Bridge over the Douro. 10 figures. Designs submitted to the bridge commission at Oporto ... 4060
Perspective Carriage Draughting. By ADOLPHUS MÜLLER. 1 figure.—Extension top phaeton to scale ... 4062
The Driving of Nails ... 4062
Brewing in Austria. 8 figures. Austrian brewery plant.—Details, elevation, and section, machinery, etc ... 4059
Josiah Timmis Smith, C.E., Manager of the Barrow Hematite Steel Works.—The improvements in the working of steel introduced at Barrow ... 4061

II. ARCHITECTURE, ART, ETC.—Artists' Homes. No. 9.—Mr. S. Luke Filde's house and studio, Holland Park, Kensington. Full page illustration and 8 figures, plans, elevations, and sections ... 4058
Carved Pedestal Library Table in Italian Walnut with Marquetry in Three Colors. 1 large illustration ... 4058
A Military Tournament.—Sword versus Lance.—Full page illustration.—Drawing by John Charlton ... 4058

III. GEOGRAPHY, ASTRONOMY, ETC.—Pike's Peak a Volcano ... 4058
Climatic Changes in Asia ... 4058
Limit of Planetary Stability. By Prof. DANIEL KIRKWOOD. The Earth and the Moon.—The Martian System.—Other Secondary Systems ... 4063
Pandermite. A New Boracic Mineral. By C. G. WARNFORD LOCK ... 4062

IV. ELECTRICITY, ETC.—A New Electric Motor. By WILLIAM WOODNUTT GRISCOM ... 4062
An Essay on the Natural Enemies of the Telephone. By T. D. LOCKWOOD ... 4059
Combined Induction Machine ... 4059
Spiral Polarization ... 4059

V. TECHNOLOGY, ETC.—The Bethnal Green Museum, London. By F. T. ASCHMANN ... 4057
Reversal of the Image on Gelatino-Bromide Plates ... 4062

VI. NATURAL HISTORY, ETC.—The Native Silks of Assam. By C. G. WARNFORD LOCK ... 4062
The Natural History of the Jews ... 4062

PATENTS.

In connection with the **Scientific American,** Messrs. MUNN & Co. are Solicitors of American and Foreign Patents, have had 35 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 37 Park Row, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C

* It has been recently shown that Bessel's mass of the ring is much greater than the true value.

* See SCIENTIFIC AMERICAN SUPPLEMENT of January 1, 1881, p. 4165.